233-7

DEPARTMENT OF THE INTERIOR, CANADA

WATER POWER BRANCH

J. B. CHALLIES, SUPT.

WATER RESOURCES PAPER NO. 7

MANITOBA WATER POWERS

BY

D. L. McLEAN, S. S. SCOVIL and J. T. JOHNSTON

FOR

THE MANITOBA PUBLIC UTILITIES COMMISSION

Prepared under the direction of the Superintendent of Water Power.

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
GOVERNMENT PRINTING BUREAU
1914

DEPARTMENT OF THE INTERIOR, CANADA.

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REPORT

ON

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Prepared under the direction of the Superintendent of Water Powers.

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OTTAWA
PRINTED BY J. DE L. TACHÉ, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1914

To His Royal Highness Field Marshal Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., etc., etc., etc., Governor General and Commander-in-Chief of the Dominion of Canada.

MAY IT PLEASE YOUR ROYAL HIGHNESS:

The undersigned has the honour to lay before Your Excellency the report on Manitoba Water-powers by the Engineers of the Dominion Water Power Branch.

Respectfully submitted,

WM. J. ROCHE,
Minister of the Interior.

OTTAWA, February 12, 1914.

DEPARTMENT OF THE INTERIOR,
OTTAWA, February 12, 1914.

The Honourable WM. J. ROCHE,
Minister of the Interior.

SIR,—I have the honour to submit the report on Manitoba Water-powers by the Engineers of the Dominion Water Power Branch, and to recommend that it be published.

I have the honour to be, sir,
Your obedient servant,

W. W. CORRY,
Deputy Minister of the Interior.

WATER POWER BRANCH,
OTTAWA, February 11, 1914.

W. W. CORY, Esq., C.M.G.,
Deputy Minister of the Interior.

SIR,—I beg to submit herewith the report on Manitoba Water-powers by the Engineers of the Dominion Water Power Branch, and would recommend that it be published, and that a sufficient number of copies be printed to permit of its being widely distributed among those interested in the question of water-power development in Canada.

Respectfully submitted,

J. B. CHALLIES,
Superintendent of Water Power Branch.

DEPARTMENT OF THE INTERIOR,
WATER POWER BRANCH,
UNION BANK BUILDING,
OTTAWA, December 12, 1913.

To His Honour, Judge H. A. ROBSON,
Public Utilities Commission, Winnipeg.

SIR,—By direction of the Honourable W. J. Roche, Minister of the Interior, I beg to submit the following report respecting the physical features of the water-powers within the province of Manitoba, which you have requested to be prepared by the engineers of the Water Power Branch, who have been making a systematic study of water-power and stream flows throughout the province.

In brief, the report shows that the power possibilities of the smaller rivers of the province are limited and of local importance only. The main sources of dependable power in commercial quantities are: The Winnipeg river, Grand rapids on the Saskatchewan river, and the large rivers of the north, including the Churchill, Nelson and Berens.

The power possibilities of the far northern rivers are enormous, and will surely be of great moment in the future development of Manitoba's hinterland. Little is known of these northern rivers—and results from reconnaisance surveys only—however, there are sufficient reliable data to indicate that enormous amounts of dependable power, feasible of development, simply awaits a market to be harnessed.

Fortunately the drainage basins of the Winnipeg and the English rivers, lying within easy transmission distance of the present commercial centres of Manitoba, can furnish sufficient hydro-electric energy to meet any anticipated power requirements of the present settled portions of the province.

The increase in efficiency of electrical machinery, the greater distance to which energy can be transmitted, the advance generally in the electrical industry, the already great and ever-increasing cost of good steam coal (a matter of special importance to Manitoba), all tend to make the development of dependable water-power in the province of Manitoba unusually attractive.

Furthermore, the constant growing demand for hydro-electric energy for manufacturing, transportation and municipal purposes in and around the city of Winnipeg, has made the question of power development on the Winnipeg river one of the most important administrative matters occupying the attention of the Department of the Interior.

Fortunately, a well-considered and cautious policy of water-power administration has been determined upon, and regulations put into force (see chapter 9) which afford every reasonable protection to the public in the way of limited grants, rentals and control of rates, both subject to periodic revision, and at the same time providing sufficiently attractive opportunities for investment to actively interest the capitalist.

Consistent with the policy of the Dominion Government, the Minister of the Interior has instructed that all vacant Dominion land contiguous to power sites on

the Winnipeg river, or any other river in Manitoba, be reserved for disposition only under the water-power regulations referred to.

It was early found necessary, in connection with the consideration of sundry applications for power privileges on the Winnipeg river in Manitoba, for the Water Power Branch to have extensive power and storage studies made of that portion of the Winnipeg river within the province of Manitoba. These investigations show that at eight distinct power sites, by means of storage easily and cheaply accomplished at the Lake of the Woods, at Lac Seul and other lakes in the province of Ontario, it is possible and economically feasible to develop over 409,700 continuous 24-hour horse-power, all within eighty miles of the city of Winnipeg, and within feasible transmission distance of all commercial centres of the present settled portions of the province.

Of the eight possible power sites on the Winnipeg river, there are three now under development, representing a total power capacity of 199,000 24-hour horse-power. One site is completely developed by the Winnipeg Electric Railway Company on the Pinawa channel, and produces about 26,500 horse-power under most favourable conditions. Another site at Pointe du Bois falls, developed by the city of Winnipeg, produces at the present time about 20,800 horse-power, but is capable of extensions to a maximum of 77,000 24-hour horse-power. Development at the third power site at Great falls, having a maximum possible development of 95,500 24-hour horse-power, is about to be commenced.

There is, therefore, at the present time about 47,300 horse-power produced on the Winnipeg river, and transmitted for use in and around the city of Winnipeg, which can, with the two present plants, be increased to 103,500 24-hour horse-power.

The five remaining power sites on the Winnipeg river are under the control of the Dominion Government, and can furnish a further amount of 24-hour power to a maximum extent of 210,700 horse-power.

In addition, there are several important power sites on the Winnipeg and English rivers within the province of Ontario, which are within easy transmission distance of Winnipeg.

Surely this abundance of dependable and economically feasible power spells an assured industrial future for the province of Manitoba, and especially for the cities of Winnipeg, Portage la Prairie and Brandon.

It is interesting to note that the Winnipeg river, in its natural condition, forms one of the most notable power rivers in the world, having a total drop in the province of Manitoba of 271 feet, and in average years its maximum flowage being only about four times its minimum—about 12,000 cubic feet per second. Full information regarding the enormous potential power resources of the river is set out in detail in chapter 3, by Mr. J. T. Johnston, hydraulic engineer of the Water Power Branch, under whose direction the surveys and investigations of the branch have been carried on. Particular attention is called to the two diagrams on plates 9 and 10, which illustrate graphically the power situation on this river under conditions of regulation and non-regulation.

The preparation of the material in this report, excepting that relating to the Winnipeg river, was commenced by Mr. D. L. McLean, chief engineer of the Manitoba Hydrographic and Power Surveys, but owing to his resignation from the department in October last, to accept a position with the engineering staff of the city of Winnipeg, most of the work has developed upon Mr. S. S. Scovil, assistant chief engineer, to whose energy and resourcefulness is due a great measure of credit for the compilation of the material in the short time available.

It might seem pertinent to put on record more complete data bearing on the hydrology and other natural phenomena of the river basins of Manitoba which the engineers of the Water Power Branch have collected, collated and compiled, but these data will shortly be published in a forthcoming report of the work of the Manitoba Hydrographic and Power Surveys, and, furthermore, the limited time available for the completion of this report prevents satisfactory deductions therefrom. It has therefore been considered advisable to furnish general hydrographic data only, and to suggest that persons desiring to pursue questions of water supply further should either communicate with the chief engineer of the Manitoba Hydrographic and Power Survey or await the issue of the report referred to.

It is regretted that the limited time available for the preparation of this report—due to the necessity of having it placed in your hands by the 15th of December—has prevented a more complete and careful compilation of the available material regarding the physical features of power in Manitoba.

I have the honour to be, sir,

Your obedient servant,

J. B. CHALLIES,

Superintendent of Water Power Branch.

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CHAPTER 1

GENERAL SUMMARY OF POWER SITUATION IN MANITOBA

CHAPTER 1.

GENERAL SUMMARY.

That Manitoba is richly endowed with numerous water-powers has been generally known, but previous to the investigations of the Water Power Branch of the Department of the Interior of Canada, their extent and magnitude have only been approximated.

Recognizing the great value of such powers, and with a view to the power requirements of both the present and future, a complete study has been made of certain power rivers, and is being made of all other power rivers throughout the province. In such studies it is the aim of the department to form a comprehensive scheme contemplating the maximum development of the total head available upon a river.

The great power possibilities of Manitoba are due to the geological and topographical features of the province. The central portion of Manitoba acts as a collecting basin for the waters from an immense drainage area. This vast area extends from the Rocky mountains practically as far eastward as lake Superior; it also comprises a great portion of the Northern States and reaches into the northerly lands of Western Canada.

As these waters reach the central portion of the province, a depression occurs between the prairie steppes and the Laurentian plateau, through which an extensive fall is available for power development. Lake Winnipeg forms the reservoir into which is collected practically all the run-off from the above described drainage area. From this lake to Hudson bay the flow is concentrated in the Nelson river, on which a drop of approximately 700 feet occurs.

From the above it is apparent that the major portion of the powers throughout the basin are concentrated within the lower portion of the drainage area, or more particularly in Manitoba.

The powers are naturally separated into two divisions, viz., those occurring on the rivers draining into lake Winnipeg, which are situated in the older or southern portion of the province, and secondly, the powers which occur in the northern portion lying in the drainage from lake Winnipeg. Under these two divisions the estimated powers of the province are tabulated below.

It should be noted that while, on many rivers, possible power concentrations have been investigated and an estimate of the available power is given for various sites, yet as future investigations will show, further power may be available on such rivers. Again, in the case of other rivers, no surveys to determine the extent of concentration available have as yet been made, and in these cases where a record of the flow has been obtained, an estimate is made of the power available per foot head. In many cases the power has been estimated both for the extreme minimum flow and for the lowest monthly mean flow of the highest six months of the year, as obtained from the present record of discharges.

The horse-power has been calculated for a turbine efficiency of 80 per cent, while no estimate has been made as to the power available during short periods of high or peak loads, since this would be impossible without a knowledge of the circumstances for which the power might be desired. The powers on the Winnipeg river have been considered on a 75 per cent efficiency basis, for reasons set out in the chapter on that river.

The data for these tables, and also for the more detailed description of the rivers as given in the following chapters, have been secured in the field by the Manitoba

Hydrographic and Power Surveys, and office compilation in Winnipeg and Ottawa. The power surveys carried out and the gauging stations maintained by the above surveys are shown on plate No. 34.

The following tabulation of the powers in the province is not intended to fully cover the subject, as many rivers are as yet to be investigated:—

TABLE No. 1.

I.—POWERS OF SOUTHERN AND CENTRAL PORTION OF PROVINCE.

(a) *Existing Water-Power Developments.*

River.	Plant.	Power Developed.
		* Horse Power.
Winnipeg	City of Winnipeg	20,800
"	Winnipeg Electric Railway Co.	26,500
Little Saskatchewan	Brandon Electric Light Co	500
" "	Minnedosa Power Co.	500
Shell	Assessippi	50
Total		48,350

* The city of Winnipeg plant can ultimately supply, with a regulated river, 76,800 24-hour power.

TABLE No. 2.

(b) *Possible Water-Power Developments.*

WINNIPEG RIVER.

Site.	Head.	24-HOUR POWER AT 75 PER CENT EFFICIENCY.	
		12,000 sec.-ft.	20,000 sec.-ft.
Slave Falls	26	26,600	44,400
First Site, Seven Sisters	39	11,600	34,800
Second Site, Seven Sisters	37	12,600	37,900
McArthur	18	18,400	30,700
Du Bonnet	56	57,300	95,500
Pine	37	37,900	63,100
Totals		164,400	306,400

TABLE No. 3.

River.	Site.	Horse-power on 80 per cent Efficiency, 24 hours. Min. flow.	Total.	Reg. flow.	Total.	Period of six highest mos. of yr.	Total.
Whitemouth	No. 1	46				180	
"	No. 2	46	92			180	360
Brokenhead	X	0				8	
Roseau	X	0				3·6	
Red	t. Andrews					3,270	3,270
Pembina	X						
Souris	X	0·5				4·5	
Shell	X					18	
Assiniboine	Currie's Landing	653				1,685	1,685
"	Headingly	36				108	
"	Millwood	14				64	
Little Saskatchewan	No. 1	180		840			
"	" 2	203		945			
"	" 3	212		987			
"	" 4	90	685	420	3,192		
Valley	" 1	34		102		172	
"	" 2	34		102		172	
"	" 3	101		303		501	
"	" 4	94	263	282	789	468	1,316
Mossy	" 1	455					
"	" 2	455	910				
Waterhen	Meadow Port	6,800					
Fairford and Dauphin	No. 1	3,630					
"	" 2	2,950					
"	" 3	12,706					
"	" 4	7,260	26,546				
Swan		4·5				14·5	
Red Deer		13·7					
Manigotagan	No. 1	90		449			
"	" 2	22		109			
"	" 3	33		163			
"	" 4	82		408			
"	" 5	33		163			
"	" 6	49		245			
"	" 7	92		462			
"	" 8	76		381			
"	" 9	57		286			
"	" 10	74	608	368	3,034		
Saskatchewan	Demi Charge	6,808				46,289	
"	Red Rock	6,808				46,289	
"	Grand Rapids	36,305	49,921			246,877	339,455

The estimated power as shown refers only to horse-power per foot head, as investigations as to possible concentrations are as yet to be made.

TABLE No. 4.

Powers of Northern Portion of Province.

River.	Site.	Horse Power based on 80 per cent Efficiency. Estimated Minimum Flow, 50,000 sec. ft.
Nelson	Whisky Jack portage	181,150
"	Ebb and Flow rapids	77,150
"	White Mud rapids	135,800
"	Bladder rapids	90,575
"	Chain of Rock rapids	158,510
"	Devil's rapids	113,220
"	Grand rapids	122,530
"	Birthday rapids	103,375
"	First Gull rapids	77,150
"	Second Gull rapids	95,105
"	Third Gull rapids	90,575
"	Fourth Gull rapids	135,860
"	First Kettle rapids	77,150
"	Second Kettle rapids	97,370
"	Third Kettle rapids	181,150
"	Upper Long Spruce rapids	181,150
"	" "	235,495
"	Upper Limestone rapids	149,450
"	Lower Limestone rapids	185,680
		2,548,505

ACKNOWLEDGEMENTS.

Acknowledgements of the generous assistance, which has been greatly appreciated, are due to the following:—

Col. H. N. Ruttan, city engineer, Winnipeg.
D. A. Ross, consulting engineer, Winnipeg.
Winnipeg Electric Railway Company.
J. G. Glassco, manager, City Light and Power Department.
R. A. Speakman, city engineer, Brandon.
Department of Public Works of Canada.
Marine and Fisheries Department.
Meteorological Service.
United States Weather Bureau.
Water Resources Branch, United States Geological Survey.
The Commission of Conservation.
J. B. McRae, consulting engineer, Ottawa.

WATER-POWERS OF MANITOBA

CHAPTER II

HYDROLOGY

CHAPTER II.

RAINFALL, EVAPORATION AND RUN-OFF.

General.

Two main factors enter into the investigation of any possible power development—the head and flow available. While the first of these is obtainable through field survey and a knowledge of the extreme and average stages of river level, yet the second comprises an extensive study of the flow which, dependent on natural conditions, varies not only with the season and year, but also with the topography and character of the drainage area. Primarily, all waters carried by rivers comes from the rainfall or the melting of snow which has been precipitated during the winter months. Of this rainfall a portion evaporates, a portion enters the soil and is either absorbed by plant growth or, by ground flow reaches the rivers or lakes, while the third portion finds its way into streams as surface flow or run-off.

Rainfall.

While the record of the run-off from a drainage area is of first importance in the question of power development, yet the rainfall or precipitation is also of extreme value in that these latter records, if of a more extensive period than those of the run-off, would indicate the high and low range of flow which might be expected. In a like manner, rainfall records in a drainage basin in which no discharge measurements are available can be used for the estimation of the flow based on the rainfall and run-off records of an adjacent area.

Throughout the southern portion of the province of Manitoba, rainfall records have been obtained by the Meteorological Bureau of the Marine and Fisheries Department of Canada, and these records are tabulated for the various stations on Plate No. 1.

It is well known that the precipitation not only shows a variation from season to season, but also that a record extending over a short period of years is not sufficient to give the mean annual rainfall, but rather that for this mean a period of cycle of long term should be considered. As the stations throughout the province at which long-term records have been obtained are not numerous, it is necessary to carry out some system of compensation for the shorter records of the adjacent stations. As is shown on the curves on plates No. 2 and No. 3, the records of the rainfall at the long-term stations, shown separately for the eastern and western portions of the province, have the same general features from period to period. Assuming that the intermediate stations of shorter terms will also range in a like manner from periods of heavy to those of light precipitation in the same years as at the long-term stations, the probable ratio of these short-term records to that of a long term for the same station, has been based on the ratio of the precipitation at an adjacent long-term station during similar years, to the precipitation of the total period of the long-term station. As shown on plates No. 2 and No. 3, the precipitation, together with the duration of the record, are given for various stations throughout the province. The ratio of all short-term records has been computed from the nearest long-term station as tabulated in the table, and a compensated annual mean for the station has been calculated. From these

compensated results, the location of lines of equal precipitation has been determined and are shown for the southern portion of the province on plate No. 34. In the preparation of this isohyetal map it will be noted that it has been necessary to use several records of very short period, but, in the main, these records have been found to verify the lines of equal rainfall between the long term stations.

Evaporation.

Of the tremendous losses due to evaporation from the ground surface, very little is known. It is impossible to arrive at such losses by taking the difference between rainfall and run-off, as in this there would also be included the losses due to absorption by the soil and by vegetation, and again the rate of run-off does not depend altogether upon the rainfall. It is known, however, that a variation does occur in the evaporation depending upon many factors in which are comprised atmospheric conditions, geological and topographical features of the drainage basin, together with the extent of forestration and vegetation.

A more complete study has been made of the evaporation from the water surface of lakes and rivers, the greatest use of such studies being in the investigation of storage and the losses which are likely to occur on such reservoirs through evaporation. That the losses on lake areas are very great, and often of greater extent than precipitation, is well known.

In connection with the investigation of the water-powers on the Winnipeg river, and with the view to maximum efficiency in the development of powers thereon, it has been found necessary to consider and investigate the possibilities of conserving the flood waters. Accordingly, very complete studies are being made of the storage possibilities of the immense lake areas of the Lake of the Woods district. These studies have naturally included the securing of data with respect to evaporation, and on May 1, 1913, an evaporation station, together with numerous instruments for the recording of all atmospheric phenomena which affect the extent of evaporation, was established on the Lake of the Woods in the vicinity of Keewatin, Ont.

Run-off.

It is readily seen that the extent of run-off or stream flow depends principally upon the depth of rainfall and the area of the basin drained, yet many other factors entering therein and of extreme importance comprise such as the geological formation and topographic features of the drainage area, whether of sloping land tending to give a rapid run-off, or of low-lying swampy areas from which the flow is more or less uniform, and also dependent upon the extent of the growth of timber and vegetation, together with numerous other factors.

While much can be gained from the studies of rainfall and evaporation and the physical features of a drainage area, yet the most accurate and reliable data with regard to run-off or stream flow are obtained by a systematic gauging and metering of the flow of the stream to secure the continuous run-off, and extending over sufficient time to obtain the extreme fluctuation. The run-off of any stream varies not only from season to season, but also to such an extent from year to year that the same conditions are not likely to occur on a river in any two successive years. Records for a cycle of at least seven years are, as a rule, necessary to cover the yearly variation to be anticipated.

Not only is the study of the run-off of streams of extreme importance in the investigations of power possibilities, but it is also of extreme value in the investigation of possible reclamation of low lands through drainage, or the reclamation of arid lands through irrigation. Such a study is also necessitated on many rivers where schemes for the betterment of navigation are proposed.

MANITOBA HYDROGRAPHIC SURVEY.

Previous to the year 1911, there had been no systematic or reliable gathering of data relating to the flow of the rivers in the province of Manitoba. Some few scattered discharge measurements had been made throughout the province, but not of sufficient extent to give information as to the continuous flow of any rivers as extending over various stages of their discharge. In the above year a systematic study of the power possibilities of the Winnipeg river was inaugurated by Mr. J. B. Challies, Superintendent of Water Power Branch, Department of the Interior of Canada. The field work, of which Mr. D. L. McLean was in charge, consisted of a detail survey of the river and its power possibilities in Manitoba, and also included the establishment and maintenance of gauging stations on the river. This work, in the spring of 1912, was further enlarged so as to embrace a systematic study of the flow and power possibilities of all rivers throughout the province. For this extensive work, the Manitoba Hydrographic Survey was organized, with the appointment of Mr. D. L. McLean as chief engineer, the work still being carried on under the supervision of the Water Power Branch. Numerous gauging stations were established on the rivers and streams throughout the province, and since that time the gathering and compiling of the data has been vigorously carried on. The various metering and gauging stations at present maintained, together with the extent of the power surveys of the province, are shown on the plan on plate No. 34.

PLATE 1.

MANITOBA HYDROGRAPHIC SURVEY.

MANITOBA RAINFALL RECORDS.

THIS TABLE has been compiled from the Meteorological Service Records; 10 inches of snow has been assumed equal to 1 inch of rainfall.

Station.	Elevation.	Duration of Record.	Years.	Annual Mean.	Long term Mean based on Record.	Probable ratio of Rainfall in this period to long term Mean.	Compensated annual Mean for this station.
				Inches.	At.	p.c.	
Almasippi	... .	1903—1912	10	20·90	Winnipeg	100	20·9
Asessippi	....	1886	1	13·52	Minnedosa	65	18·3
Adelphi	....	1888 1912	1	12·25	Bottineau, N. Dak.	86	14·0
Brandon	1,176	1885—1912	21	17·16	... ...	100	17·2
Birtle	1,703	1884	1	25·40	Hillview	130	17·8
Barnardo	... ...	1891—1905	9	16·80	"	122	13·1
Berens River	710	1908—1912	5	21·22	....		
Beausejour	....	1886—1888	3	15·09	Winnipeg	52	22 3
Barnside	....	1886—1890	4	14·95	Stony Mountain	70	19·4
Craigilea	....	1888	1	15·05	Winnipeg	78	18·4
Channel Island	....	1890—1905	15	17·10	Stony Mountain	73	21·7
Cartwright	1,533	1881—1912	15	19·82	Bottineau	123	15·3
Clarkleigh	....	1886—1888	3	18·10	Stony Mountain	86	20·6
Carberry	1,258	1909—1911	3	17·07	Minnedosa	90	18·8
Clandeboye	....	1884—1888	4	16·72	Stony Mountain	72	21·4
Elkhorn	....	1895—1901	4	17·81	Hillview	115	15·1
Emerson	....	1894—1898	3	21·67	Pembina, N. Dak.	106	20·4
Eden	....	1884—1887	4	17·14	Minnedosa	74	21·6
Fort Ellice	....	1885—1891	7	15 25	Hillview	99	15·4
Gretna	760	1903—1910	8	18 67	Pembina, N. Dak.	94	19·8
Gilrad	....	1904—1905	2	11·77	Bottineau	93	12·6
Hillview	1,400	1891—1912	20	20·00	Minnedosa	114	17·2
Minnedosa	1,690	1881—1912	32	17·82	....	100	17·8
Morden	978	1888—1912	17	19·69	Pembina, N. Dak.	93	21·1
Norquay	798	1888—1912	16	19·00	Winnipeg	85	21·9
Oakbank	740	1886—1912	22	21 04	....	100	21·0
Oakdale Park	740	1905	1	18·48	Minnedosa	110	16·6
Portage la Prairie	830	1884—1908	14	17·00	Winnipeg	93	18·2
Pilot Mound	1,547	1887—1898	4	18·74	Pembina	93	20·1
Rapid City	1,180	1882—1912	15	17·65	Minnedosa	91	18·2
Russell	....	1884—1904	9	15·18	Hillview	89	16·8
St. Albans	1,060	1885—1912	25	17·66	....	100	17·7
Swan River	....	1901—1910	4	20·85			
Shell River	....	1884—1890	6	15·37	Minnedosa	89	16·9
Stony Mountain	803	1878—1909	22	17·64	Winnipeg	83	20·6
Turtle Mountain	2,150	1884—1904	12	21·92	Bottineau	141	12·9
Treherne	1,212	1910—1912	3	18·28	Winnipeg	93	19·6
Winnipeg	760	1873—1912	40	21·55	....	100	21·6
Kenora (Ont)	....	1886—1912	9	22·41	Winnipeg, P. Arthur	93	24·0
Norway House	....	1896—1904	8	18·90			
York Factory	....	1875—1882	3	20·38			
Moosomin (Sask	....	1901—1905	3	17·39	Hillview	113	15·1
Saltcoats (Sask)	....	1900—1903	4	15·69	Hillview	122	12 2
Port Arthur (Ont)	....	1886—1912	27	23·08			

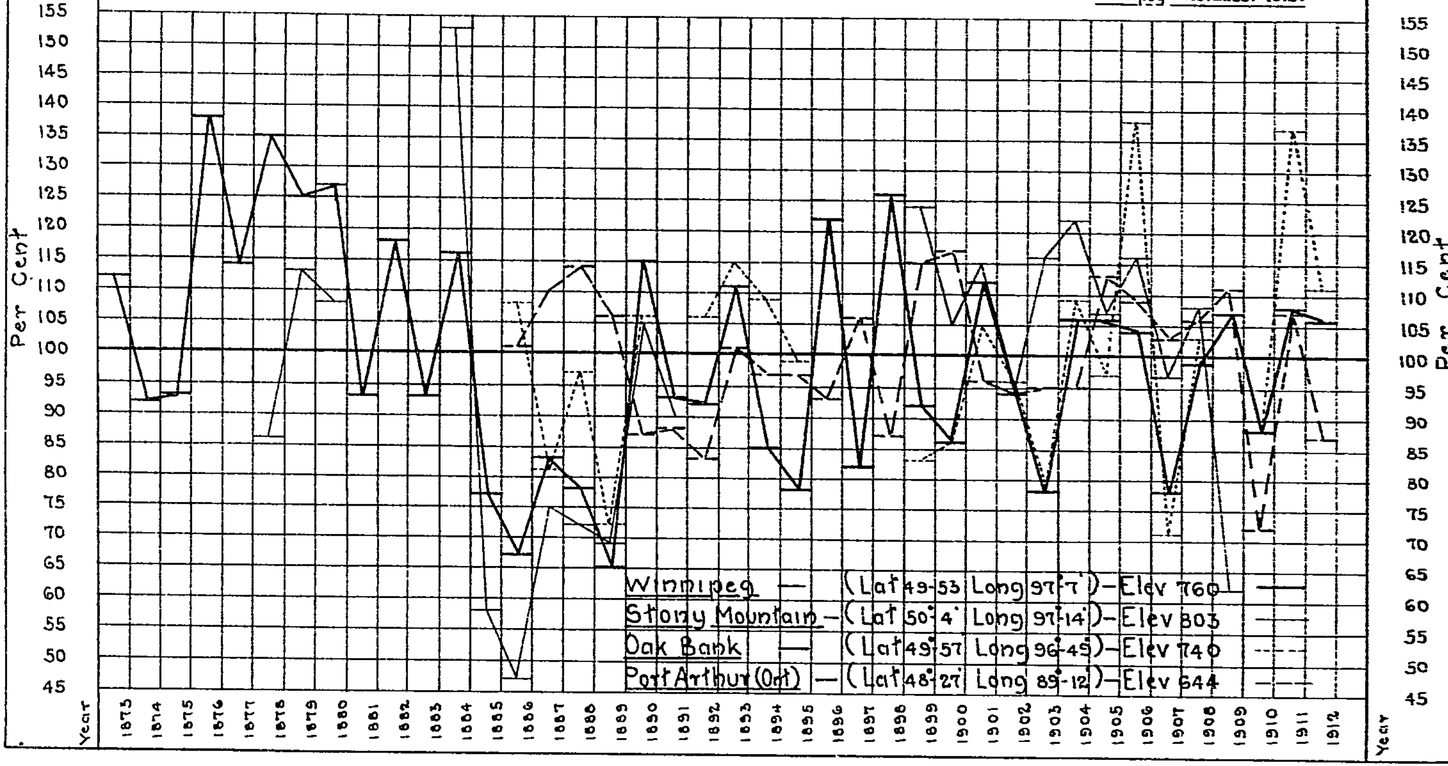
November, 1913.

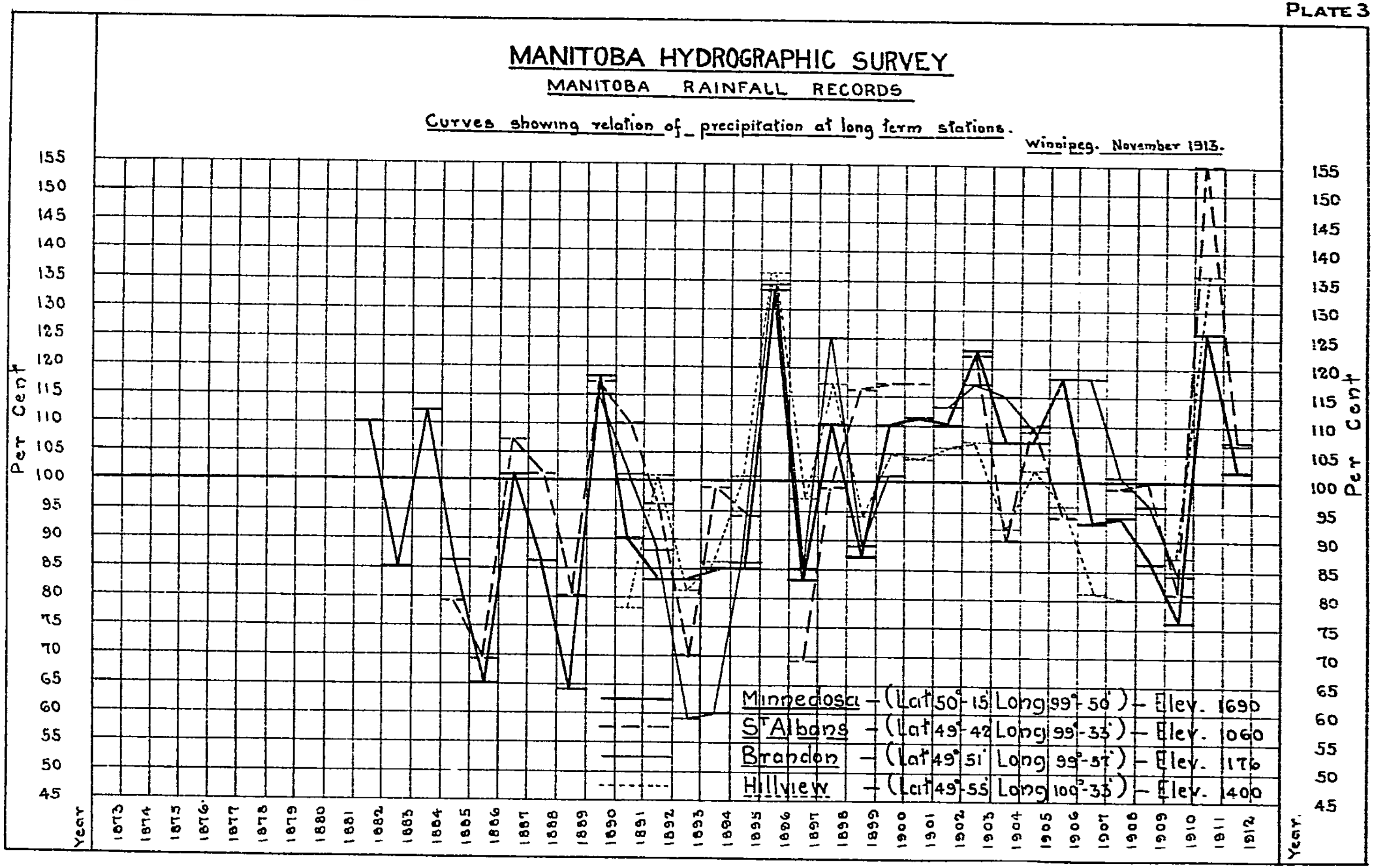
PLATE 2

MANITOBA HYDROGRAPHIC SURVEY

MANITOBA RAINFALL RECORDS

Curves showing relation of precipitation at long term stations. Winnipeg November 1913.




MANITOBA HYDROGRAPHIC SURVEY
MANITOBA RAINFALL RECORDS
Curves showing relation of precipitation at long term stations.
Winnipeg. November 1913.
Per Cent
Year
Minnedosa – (Lat 50°-15' Long 99°-50') – Elev. 1690
S^t Albans – (Lat 49°-42' Long 99°-33') – Elev. 1060
Brandon – (Lat 49°-51' Long 99°-57') – Elev. 1176
Hillview – (Lat 49°-55' Long 100°-33') – Elev. 1400

WATER-POWERS OF MANITOBA

CHAPTER III

WINNIPEG RIVER

CHAPTER III

WINNIPEG RIVER.

1. NECESSITY FOR INVESTIGATION.

It has long been recognized that there is an enormous reserve of potential water-power on the Winnipeg river within the province of Manitoba. The rapidity with which the existing developments on the river have been, and are being increased to their capacity, and the active interest that has been taken in the undeveloped power sites of the river, have compelled the Dominion Government to give the water-power resources on this river careful and full consideration. Within the last few years there have been presented to the Dominion Government many applications for power privileges on this river; schemes have been proposed for the utilization of various portions of the natural fall, some contemplating the combination of several falls by the concentration of their respective drops at one power site, and others simply proposing the utilization of the drop at a particular fall. These have been so varied and so conflicting, and at the same time supported by such reputable engineering advice, that the government found it inadvisable to commit itself with respect to any further developments on the river until it had first caused to be made a complete survey and investigation of the whole river, with a view to securing such information as would enable the dictation of developments which would contemplate the maximum possible advantageous utilization of the water-power resources of the river. These investigations were started early in the year 1911, under the consulting advice of Mr. J. B. McRae, C.E., of Ottawa, and the field work has proceeded vigorously to completion under charge of Mr. D. L. McLean. For the purpose of this report for the Public Utilities Commission, which had to be completed by December 15, plans based on this field work have been rushed to completion, and a preliminary provisional estimate made by the engineers of the Water Power Branch, of the best method of concentrating the various separate falls of the river to enable all the natural fall to be utilized for power purposes, and at the same time have each unit development a component part of the comprehensive scheme for the whole river. These concentrations are indicated in plan and profile on plates No. 6 and No. 7. A study of this profile will illustrate the completeness with which the objects of the investigation have been realized, and the full conservation of the power resources of the river provided for.

2. DESCRIPTION OF RIVER AND DRAINAGE BASIN.

The Winnipeg river is one of the most notable power rivers on the continent; it flows in a westerly direction, connecting the Lake of the Woods with lake Winnipeg. The basin drained (see plate No. 4), comprises an immense area of some 55,000 square miles, lying at the westerly end of the Laurentian plateau. As is typical of Laurentian country, the area is dotted with innumerable muskegs and lakes, the latter varying in size from small ponds to the Lake of the Woods, with an area of 1,500 square miles. Certain general characteristics apply to the drainage basin as a whole, since practically the entire area is of Laurentian formation with an overlying soil of glacial origin. The country is rough and hilly, with large areas of rock outcrop. This latter feature applies in the main throughout the Winnipeg river, and lends itself to a characteristic formation throughout the river channel, which is of exceptional value

in the interests of power development. The larger proportion of the river bed in the province of Manitoba, consists of a series of deep cup-like basins, forming small lake-like expanses with little or no current. The river flow finds its way from these basins by falls and rapids over the rock formation which is always in evidence at the outlets, and which forms at once the means of egress from and the controlling feature of the basin water level. These falls form the natural power sites along the river.

A valuable timber growth, including spruce, tamarack, birch and pine occurs throughout the whole district. Lumbering is carried on extensively and, in addition, pulp and paper industries have been established at Fort Frances and Dryden. Notwithstanding the great extent of rock outcrop, considerable area is available for farming, this applying more especially to the Whitemouth and Rainy River districts. While there are several prosperous towns, such as Fort Frances, Rainy River and Kenora in the basin, yet the greater portion of the country has not been settled, and is still in the state of nature.

The upper watershed reaches to the height of land separating the Atlantic drainage from that of Hudson bay, into which the waters of the Winnipeg river eventually flow. North lake, which is situated on the international boundary, some forty-five miles west of lake Superior, is the head-water of the drainage basin. From North lake the stream flows westward, passing through many small lakes, collecting the flow of numerous tributaries and finally discharging into Rainy lake. These upper waters, in the main, constitute a portion of the International boundary. Many streams heading in upper lakes and muskegs also contribute to the flow from Rainy lake. This latter has a surface of 330 square miles, and a drainage area of some 14,600 square miles. Rainy river, which is the outlet, discharges into the Lake of the Woods. From this latter lake to lake Winnipeg, the river is known as the Winnipeg. Forty miles down the river from the Lake of the Woods, the flow of the English river enters that of the Winnipeg. This tributary is almost of as large dimensions as the river into which it flows, as it drains an area of 22,000 square miles, while the Winnipeg, at the Lake of the Woods outlets, has a drainage of 25,000 square miles. From the Lake of the Woods to Lake Winnipeg, there is a total drop of 341 feet, and of this 70 feet takes place above and 271 feet below the junction with the English river; as this junction occurs practically at the boundary between Ontario and Manitoba, it follows that the combined flow of the two rivers, together with the greater drop as noted above, are available for power purposes in Manitoba. Of this head a considerable portion is already being utilized by existing developments on the river.

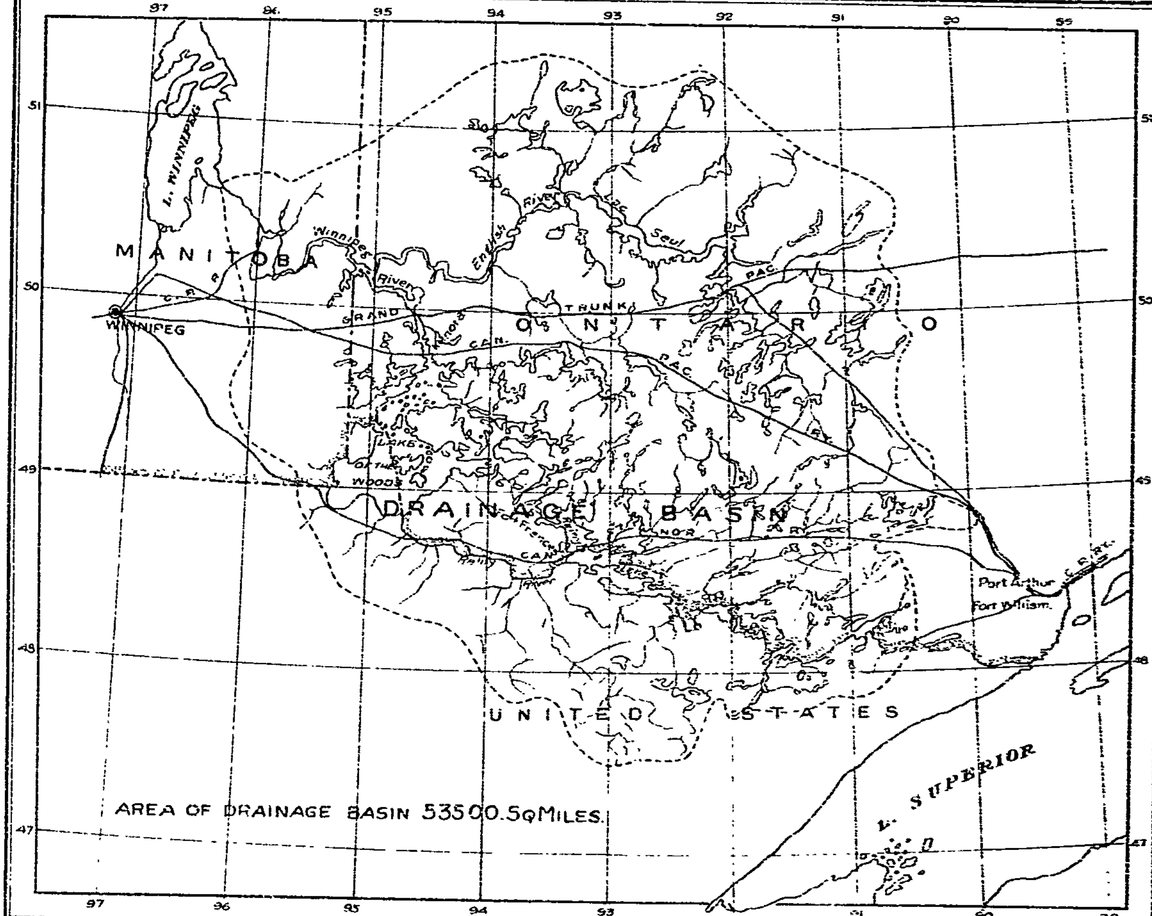
3.—Flow Records.

Estimates of the daily flow of the Winnipeg river have been compiled by the Manitoba Hydrographic Survey, based on the discharge measurements secured by them, together with results of measurements supplied by Col. Ruttan, D. A. Ross, and the city of Winnipeg power engineers. These estimated discharges, which are given in tables No. 5 to 24, are referred to the flow of the river at Pointe du Bois and extend over a period of six years. For this period a maximum flow of 53,400 second-feet and a minimum flow of 11,700 second-feet have been recorded. The high-water marks along the shore would indicate that floods of 100,000 second-feet have occurred in the past. Such floods must, however, take place at rare intervals.

4.—Storage on the Upper Waters.

The question of storage on the upper waters of the Winnipeg river is at present somewhat involved, in that the regulation of the Lake of the Woods has become an international question, and is now before the International Joint Commission. Con-

PLATE 4



DEPARTMENT OF THE INTERIOR, CANADA.
WATER POWER BRANCH.
J.B. CHALLIES, SUPT.

MANITOBA POWER SURVEY.
WINNIPEG RIVER
PLAN SHOWING
ENTIRE RIVER BASIN
Scale 50 Miles = 1 inch.

Compiled for The Manitoba Public Utilities Commission

Date Nov 27th 1913.

sidering that the lake has a tributary drainage area of 25,000 square miles and a surface area of 1,500 square miles, offering unexcelled storage facilities, it is of vital importance to the powers of the Winnipeg river that storage should be had on this lake. Partial regulation of the drainage tributary to Rainy lake is now controlled on Rainy lake by the dam of the Ontario and Minnesota Power Company at Fort Frances.

By the establishment of storage reservoirs on the English river, the flow of the latter can be regulated; and in conjunction with storage on the Lake of the Woods drainage basin, practically a complete regulation of the flow of the Winnipeg river in Manitoba can be attained.

During the period of the last six years, over which records of the flow of the Winnipeg river extend, a minimum flow of 11,700 second-feet has been recorded, while the maximum flow in the same period is 53,400 second-feet, a range of only 1 to 4, which is illustrative of the extremely low fluctuation under practically natural conditions. By an adequate system of storage, this flow can be so regulated that the minimum flow will be readily increased from about 12,000 second-feet to over 20,000 second-feet. On plate No. 5 is shown a mass curve of the flow of the river at Pointe du Bois for the period from January 23, 1906, to December 31, 1912. For this period a storage of 373 billion cubic feet would have been necessary for a complete regulation.

TABLE No. 5.

Discharge Measurements of Winnipeg River near Pointe du Bois, Man., 1906.

Date.	Hydrographer.	Gauge Height.	Discharge.
		Feet.	Sec.-ft.
March 7	Col. Ruttan	160·5[1]	19,876[2]

[1]Referred to lower gauge at Pointe du Bois.
[2]Just above falls at Pointe du Bois, one foot ice cover. Gauge height approximated.

TABLE No. 6.

Discharge Measurements of Winnipeg River near Pointe du Bois, 1907.

Date.	Hydrographer,	Gauge Height.	Discharge.
		Feet.	Sec.-ft.
Aug. 1	Pratt and Ross for Winnipeg Street Railway Company	162·2	31,047[1]
" 2	" " " " "	162·2	30,600[2]
Oct. 31	" " " " "	164·2	41,300[3]

Gauge heights referred to lower gauge at Pointe du Bois.

[1]Below diversion dam and Pinawa channel. Two channels measured to give total.
[2]Barrier chute.
[3]Otter Falls.

TABLE No. 7.

Discharge Measurements of Winnipeg River near Pointe du Bois, 1908.

Date.	Hydrographer.	Gauge Height.	Discharge.
		Feet.	Sec.-ft.
July 14.........	Pratt and Ross for Street Railway Company............	164.2	43,000
Nov. 7..	" " "	162.0	28,700

Gauge heights referred to lower gauge at Pointe du Bois.
Discharge measured at Otter Falls.

TABLE No. 8.

Discharge Measurements of Winnipeg River near Pointe du Bois, 1909.

Date.	Hydrographer.	Gauge Height.	Discharge.
		Feet.	Sec.-ft.
May 24...	Pratt and Ross for Street Railway Co.	161·0	26,360
July 17....	do do	161·25	26,000
Oct. 8	do do	160·70	22,500
Nov. 8	do do	160·55	21,770

Gauge heights referred to lower gauge at Pointe du Bois.
Discharge measured at Otter Falls.

TABLE No. 9.

Discharge Measurements of Winnipeg River near Pointe du Bois, 1910.

Date.	Hydrographer.	Gauge Height.	Discharge.
		Feet.	Sec.-ft.
July 28....	Pratt and Ross for Street Railway Co.	162.25	29,375

Gauge heights referred to Lower Gauge at Pointe du Bois,
Discharge measured at Otter Falls.

TABLE No. 10.

DISCHARGE MEASUREMENTS of Winnipeg River near Pointe du Bois, 1911.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height	Discharge.	
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.	
Feb. 4, 6, 7....	Stanford (for city of Winnipeg)..		280.5	5,475	2.26	159.26	12,375	1
Feb. 13, 14 15.	do			5,691	2.28	159.26	13,256	1
May 7	Pratt and Ross (for Street Railway Co).......					159.42	13,450	2
May 19.	do					159.87	15,800	2
Oct. 13, 14 ...	A. M. Beale (Water Power Survey). ..	3	269	7,272	3.59	161.80	26,115	3
Oct. 29..	do	1	269	7,218	3.68	161.70	26,391	3
Dec. 6, 7, 8, 9	A. M. Beale and Alex. Pirie....	1	610	21,910	1.10	160.68	24,145	4
Dec. 6, 7, 8, 9.	do	1	610	21,910	1.11	160.68	24,320	5

Gauge heights referred to lower gauge at Pointe du Bois.

[1] At city meter station 10 miles below Pte. du Bois, Man., section, ice, cover; check measurements.
[2] Otter Falls, ice measurement.
[3] Slave falls.
[4] 1½ miles above Gd. du Bonnet falls, 0.2 and 0.8 method under ice.
[5] 1½ miles above Gd. du Bonnet falls, Vert. Vol. curve method under ice.

TABLE No. 11.

DISCHARGE MEASUREMENTS of Winnipeg River near Slave Falls, 1912.

Date	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-Ft.
May 8	A. M. Beale	1197	260	6,761	2·91	160·52	19,675
May 14	G. H. Burnham ...	1197	264	7,014	3·26	161·20	22,865
May 28	A. M. Beale....	1197	273	7,366	3·65	161·88	26,887
June 1	E. B. Patterson....	1196	264	7,542	3·85	162·15	28,036
June 6.........	G. H. Burnham ...	1187	277	7,565	3·95	162·5	29,882
June 10..... ..	E. B. Patterson ...	1197	277	7,536	3·92	162·25	29,543
June 17...	W. H. Richardson....	1197	273	7,449	3·80	162·09	28,207
June 24.........	"	1197	272	7,396	3·67	161·90	27,144
July 6	"	1197	272	7,238	3·56	161·75	25,780
July 8.......	"	1197	271	7,237	3·55	161·78	25,692
July 11.........	"	1197	271	7,446	3·54	161·76	26,358
July 15.........	"	1197	271	7,446	3·58	161·77	26,656
July 16..... ..	"	1197	272	7,473	3·60	161·79	26,901
July 17.	"	1197	271	7,473	3·54	161·80	26,453
July 18.........	"	1197	271	7,446	3·52	161·78	26,209
July 19.........	"	1197	271	7,473	3·55	161·75	26,528
July 20..	"	1197	271	7,473	3·55	161·76	26,528
Aug. 20	Alex. Pirie.. ...	1197	272	7,369	3·71	161·98	27,560
Oct. 23.........	"	1197	293	7,934	4·36	163·28	34,628
Nov. 21..... ..	"	1462	291	7,785	3·95	162·85	30,761
Dec. 31....... .	"	1462	274	7,430	3·64	162·10	27,095

Gauge heights referred to lower gauge at Pointe du Bois.

TABLE

Daily Gauge Height and Discharge of

Day.	January. Gauge Height.	January. Discharge.	February. Gauge Height.	February. Discharge.	March. Gauge Height.	March. Discharge.	April. Gauge Height.	April. Discharge.	May. Gauge H'ght	May. Discharge.	June. Gauge H'ght	June. Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	...	...	161·80	27,860	160·4	19,180	160·0	16,700	159·6	14,400	160·8	21,660
2	...	...	·75	27,550	·4	19,180	159·9	16,100	·7	14,950	·8	21,660
3	...	...	...	27,550	...	18,560	·8	15,500	·6	14,400	·8	21,660
4	...	...	·80	27,860	·2	17,940	.7	14,950	·6	14,400	·8	21,660
5	...	...	162·0	29,100	·3	18,560	·6	14,400	·6	14,400	·9	22,280
6	...	...	162·0	29,100	160·4	19,180	159·6	14,400	159·6	14,400	161·0	22,900
7	...	...	161·8	27,860	·3	18,560	·6	14,400	·7	14,950	·2	24,140
8	...	...	·6	26,620	·4	19,180	6	14,400	·8	15,500	·2	24,140
9	...	...	·2	24,140	·2	17,940	·6	14,400	·7	14,950	·2	24,140
10	...	...	...	24,140	...	17,320	·6	14,400	·7	14,950	·2	24,140
11	...	...	161·2	24,140	160·0	16,700	159·6	14,400	159·7	14,950	161·4	25,380
12	...	...	·2	24,140	·2	17,940	·6	14,400	·7	14,950	·6	26,620
13	...	...	160 6	20,420	·2	17,940	·6	14,400	7	14,950	·8	27,860
14	...	...	·8	21,660	·2	17,940	·6	14,400	·7	14,950	·8	27,860
15	...	...	·4	19,180	·3	18,560	·6	14,400	·7	14,950	162·0	29,100
16	...	...	160·4	19,180	160·1	17,320	159·6	14,400	159·7	14,950	·0	29,100
17	...	...	...	19,180	·1	17,320	·6	14,400	·7	14,950	·0	29,100
18	...	...	·3	18,560	·1	17,320	·6	14,400	·8	15,500	·2	30,340
19	...	...	·6	20,420	·1	17,320	·6	14,400	160·0	16,700	·2	30,340
20	...	...	·5	19,800	·1	17,320	·6	14,400	·1	17,320	·2	30,340
21	...	...	160·6	20,420	160·0	16,700	159·6	14,400	160·1	17,320	162·3	30,960
22	...	...	·4	19,180	159·9	16,100	·6	14,400	·2	17,940	·4	31,580
23	161·5	26,000	·4	19,180	·9	16,100	·6	14,400	·2	17,940	·5	32,200
24	...	26,000	...	19,800	·8	15,500	6	14,400	·1	17,320	·6	32,820
25	...	26,000	·6	20,420	·8	15,500	·6	14,400	·1	17,320	·6	32,820
26	161·5	26,000	160·8	21,660	159·8	15,500	159·6	14,400	160·2	17,940	162·6	32,820
27	...	26,700	·7	21,040	·8	15,500	·6	14,400	·3	18,560	·6	32,820
28	...	27,400	·6	20,420	·8	15,500	·6	14,400	·4	19,180	·7	33,440
29	161·85	28,170	...	...	·9	16,100	·6	14,400	·5	19,800	·7	33,440
30	...	28,170	...	...	160·0	16,700	·6	14,400	·5	19,800	·7	33,440
31	·85	28,170	...	...	·0	16,700	...	...	·6	20,420	...	...

No. 12.

Winnipeg River, near Otter Falls, for 1907.

Day.	July.		August.		September.		October.		November.		December.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	162·7	33,440	162·2	30,340	162·9	34,680	163·6	39,020	164·2	42,740	164·2	42,740
2	·8	34,060	·3	30,960	163·0	35,300	·6	39,020	·2	42,740	·2	42,740
3	8	34,060	·2	30,340	·0	35,300	·8	40,260	·2	42,740	·2	42,740
4	·7	33,440	·2	30,340	·0	35,300	8	40,260	·2	42,740	·2	42,740
5	·8	34,060	·2	30,340	·0	35,300	164·0	41,500	·2	42,740	·1	42,120
6	162·7	33,440	162·2	30,340	163·1	35,920	·2	42,740	164·2	42,740	164·1	42,120
7	·8	34,060	·2	30,340	·2	36,540	·2	42,740	·2	42,740	·0	41,500
8	·7	33,440	·2	30,340	·2	36,540	·2	42,740	·2	42,740	·0	41,500
9	·6	32,820	·2	30,3 0	·2	36,540	·2	42,740	·2	42,740	0	41,500
10	·5	32,200	·2	30,340	·2	36,540	·2	42,740	·2	42,740	·0	41,500
11	162·5	32,200	162·2	30,340	163·2	36,540	164·2	42,740	164 2	42,740	163·8	40,260
12	·5	32,200	·2	30,340	·2	36,540	·2	42,740	·2	42,740	·8	40,260
13	·4	31,580	·2	30,340	·2	36,540	·3	43,360	·2	42,740	·8	40,260
14	·4	31,580	·2	30,340	·3	37,160	·2	42,740	·2	42,740	·7	39,640
15	·4	31,580	·2	30,340	·4	37,780	·2	42,740	·2	42,740	·6	39,020
16	162·4	31,580	162·2	30,340	163·4	37,780	164·2	42,740	164·2	42,740	163·6	39,020
17	·4	31,580	·2	30,340	·4	37,780	·2	42,740	·2	42,740	·6	39,020
18	·4	31,580	·2	30,340	·4	37,780	·2	42,740	·2	42,740	·6	39,020
19	·4	31,580	·2	30,340	·4	37,780	·2	42,740	·2	42,740	·6	39,020
20	·4	31,580	·4	31,580	·4	37,780	·2	42,740	·2	42,740	·5	38,400
21	162·4	31,580	162·6	32,820	163·4	37,780	164·3	43,360	164·2	42,740	163·4	37,780
22	·4	31,580	·6	32,820	·4	37,780	·4	43,980	·2	42,740	·4	37,780
23	·4	31,580	·6	32,820	·4	37,780	·3	43,360	·2	42,740	·4	37,780
24	·4	31,580	·6	32,820	·4	37,780	3	43,360	·2	42,740	·3	37,160
25	·4	31,580	·6	32,820	·4	37,780	·3	43,360	·2	42,740	·4	37,780
26	162·3	30,960	162·6	32,820	163·4	37,780	164·3	43,360	164·2	42,740	163·4	37,780
27	·2	30,340	·6	32,820	·6	39,020	·3	43,360	2	42,740	·3	37,160
28	·2	30,340	·6	32,820	·6	39,020	·3	43,360	·1	42,120	·2	36,540
29	·2	30,340	·6	32,820	·6	39,020	·3	43,360	·1	42,120	·2	36,540
30	·2	30,340	·7	33,440	·6	39,020	·2	42,740	·1	42,120	·2	36,540
31	·2	30,340	·8	34,060	....	....	·2	42,740	....	....	·2	36,540

TABLE

Daily Gauge Height and Discharge of

Day.	January.		February.		March.		April.		May.		June.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec. ft.	Feet.	Sec.-ft.
1	163 2	34,540	163.8	40,260	162.7	33,440	161.8	27,860	162.0	29,100	163.5	38,400
2	.2	36,540	.9	40,880	.6	32,820	162.0	29,100	.1	29,720	.5	38,400
3	.3	37,160	.8	40,260	.6	32,820	161 9	28,480	.1	29,720	.5	38,400
4	.3	37,160	.6	39,020	.5	32,200	.8	27,860	.1	29,720	.5	38,400
5	.2	36,540	.8	40,260	.5	32,200	162.0	29,100	.1	29,720	5	38,400
6	163 2	36,540	163.8	40,260	162.5	32,200	.0	29,100	162.2	30,340	163.5	38,400
7	.3	37,160	.8	40,260	.5	32,200	.0	29,100	.1	29,720	.5	38,400
8	.2	36,540	.8	40,260	.6	32,820	161.9	28,480	.2	30,340	5	38,400
9	.2	36,540	.6	39,020	.7	33,440	.9	28,480	.2	30,340	.6	39,020
10	.3	37,160	.4	37,780	.7	33,440	.9	28,480	.2	30,340	.8	40,260
11	163.2	36,540	163.2	36,540	162.6	32,820	161.9	28,480	162 2	30,340	164.0	41,500
12	.2	36,540	.0	35,300	.4	31,580	.9	28,480	.3	30,960	.2	42,740
13	.2	36,540	162.8	34,060	.4	31,580	.9	28,480	.4	31,580	.2	42,740
14	.2	36,540	.8	34,060	.4	31,580	.9	28,480	.4	31,580	.2	42,740
15	.2	36,540	.8	34,060	.3	30,960	.9	28,480	.4	31,580	.2	42,740
16	163.2	36,540	162.8	34,060	162.6	32,82	161.9	28,480	162.4	31,580	164.2	42,740
17	.2	36,540	.8	34,060	.4	31,583	9	28,480	.4	31,580	.2	42,740
18	.2	36,540	.8	34,060	.4	31,580	7	27,240	.5	32,200	.2	42,740
19	.2	36,540	.8	34,060	.4	31,580	.7	27,240	.5	32,200	.2	42,740
20	.2	36,540	.8	34,060	2	30,340	.8	27,860	.5	32,200	.3	43,360
21	163.2	36,540	162.8	34,060	162.4	31,580	161.8	27,860	162.8	34,060	164.3	43,360
22	.2	36,540	6	32,820	.4	31,580	.8	27,860	.9	34,680	.3	43,360
23	.2	36,540	8	34,060	.2	30,340	.8	27,860	163.0	35,300	.3	43,360
24	.2	36,540	163.1	35,920	.1	29,720	162.0	29,100	.0	35,300	.3	43,360
25	.1	35,920	3	37,160	.1	29,720	0	29,100	.0	35,300	.3	43,360
26	163.0	35,300	163.3	37,160	162.1	29,720	162.0	29,100	163.2	36,540	164.3	43,360
27	.0	35,300	.3	37,160	1	29,720	.0	29,100	.2	36,540	.4	43,980
28	.4	37,780	.2	36,540	.1	29,720	.0	29,100	.2	36,540	.4	43,980
29	.6	39,020	.0	35,300	.0	29,100	.0	29,100	.2	36,540	4	43,980
30	.8	40,260	...	...	.0	29,100	.0	29,100	.3	37,160	.4	43,980
31	.8	40,260	.....	....	161 9	28,480	.....	.....	.4	37,780	..	.....

No. 13.

Winnipeg River near Otter Falls, for 1908.

Day.	July. Gauge Height.	July. Dis-charge.	August. Gauge Height.	August. Dis-charge.	September. Gauge Height.	September. Dis-charge.	October. Gauge Height.	October. Dis-charge.	November. Gauge Height.	November. Dis-charge.	December. Gauge H'ght.	December. Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet	Sec.-ft.	Feet.	Sec.-ft
1	164.3	43,360	164.0	41,500	163.4	37,180	162.8	34,060	162 1	29,720	161.3	24,760
2	.4	43,980	.0	41,500	.6	39,020	.8	34,060	.0	29,100	.3	24,760
3	.4	43,980	.9	41,500	6	39,020	.9	34,680	1	29,720	.2	24,140
4	.4	43,980	163.9	40,880	.5	38,400	.8	34,060	.1	29,720	.2	24,140
5	.4	43,980	.8	40,260	.5	38,400	.7	33,440	.1	29,720	.2	24,140
6	164.4	43,980	163.8	40,260	163.5	38,400	162.6	32,820	162.2	30,340	161.2	24,140
7	.4	43,980	.8	40,260	.5	38,400	.7	33,440	.1	29,720	.2	24,140
8	.4	43,980	.8	40,260	.5	38,400	.7	33,440	.0	29,100	2	24,140
9	.4	43,980	.8	40,260	.4	37,780	.7	33,440	.0	29,100	.3	24,760
10	.4	43,980	.8	40,260	.4	37,780	.7	33,440	.0	29,100	.2	24,140
11	164.3	43,360	163.8	40,260	163.3	37,160	162.7	33,440	162.0	29,100	161.2	24,140
12	.3	43,360	.8	40,260	.2	36,540	.7	33,440	.0	29,100	.2	24,140
13	.3	43,360	.8	40,260	.1	35,920	.7	33,440	.1	29,720	2	24,140
14	.3	43,360	.8	40,260	.0	35,300	.7	33,440	.1	29,720	.2	24,140
15	.3	43,360	.7	39,640	162.9	34,680	.6	32,820	.0	29,100	.0	22,900
16	164.3	43,360	163.7	39,640	.9	34,680	162.6	32,820	162.0	29,100	161.0	22,900
17	.3	43,360	.6	39,020	.9	34,680	.8	34,060	.0	29,100	.1	23,520
18	.3	43,360	.6	39,020	.9	34,680	.7	33,440	.0	29,100	.1	23,520
19	.3	43,360	.6	39,020	.9	34,680	.7	33,440	.0	29,100	.1	23,520
20	.2	42,740	.6	39,020	.9	34,680	.7	33,440	161.8	27,860	.1	23,520
21	164.1	42,120	163.6	39,020	162.9	34,680	162.7	33,440	8	27,860	161.0	22,900
22	.1	42,120	.6	39,020	.8	34,060	.6	32,820	.8	27,860	.0	22,900
23	.1	42,120	.6	39,020	.8	34,060	.6	32,820	.7	27,240	.0	22,900
24	.1	42,120	.6	39,020	.8	34,060	.5	32,200	.7	27,240	160.9	22,280
25	.1	42,120	.6	39,020	.8	34,060	.5	32,200	.6	26,620	.9	22,280
26	164.1	42,120	163.5	38,400	162.8	34,060	162 5	32,200	161.6	26,620	160.9	22,280
27	.0	41,500	.5	38,400	.8	34,060	.5	32,200	.5	26,000	.8	21,660
28	.0	41,500	.4	37,780	.8	34,060	.5	32,200	.4	25,380	.8	21,660
29	.0	41,500	.4	37,780	.8	34,060	.4	31,580	.4	25,380	.8	21,660
30	.0	41,500	.4	37,780	.7	33,440	.4	31,580	.4	25,380	.8	21,660
31	....	....	.4	37,780	....	....	.2	30,340	....	....	.8	21,660

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE of

Day.	January.		February.		March.		April.		May.		June.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge H'ght	Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	160 89	22,280	160·99	22,900	160·89	22,280	160·10	17,320	160·00	16,700	161·20	24,140
2	·89	22,280	·99	22,900	·79	21,660	·10	17,320	159·90	16,100	·20	24,140
3	·89	22,280	99	22,900	·69	21,040	·10	17,320	·90	16,100	·25	24,450
4	·89	22,2·0	·99	22,960	·59	20,420	·00	16,700	·90	16,100	·20	24,140
5	·89	22,280	·99	22,900	·59	20,420	·00	17,700	·90	16,100	·30	24,760
6	160·89	22,280	160·99	22,900	160·49	19,800	160·10	17,320	159·90	16,100	161·30	24,760
7	·99	22,900	·19	24,140	·49	19,800	·10	17,320	160·00	16,700	·30	24,760
8	161·29	24,760	·29	24,760	·49	19,800	·00	16,700	·10	17,320	·25	24,450
9	·69	27,240	·39	25,380	·49	19,800	·00	16,700	·20	17,940	·30	24,760
10	·79	27,860	·39	25,380	·49	19,800	·00	16,700	·20	17,940	·30	24,760
11	161·69	27,240	161·39	25,380	160·49	19,800	160·00	16,700	160·30	18,560	161·25	24,450
12	·69	27,240	·49	26,000	·49	19,800	·00	16,700	·40	19,180	·30	24,760
13	·89	28,480	·59	26,620	39	19,180	·00	16,700	·50	19,800	·30	24,760
14	·89	28,480	·59	26,620	·39	19,180	·00	16,700	·60	20,420	·30	24,760
15	·79	27,860	·59	26,620	·39	19,180	·00	16,700	·70	21,040	·25	24,450
16	161·79	27,860	·59	26,620	160·39	19,180	160·00	16,700	160·70	21,040	161·30	24,760
17	·79	27,860	·59	26,620	·29	18,560	159·90	16,100	·70	21,040	·25	24,450
18	·69	27,240	·39	25,380	·09	17,320	·90	16,100	·80	21,660	·30	24,760
19	·59	26,620	·19	24,140	·19	17,940	·90	16,100	·80	21,660	·20	24,140
20	·59	26,620	160·99	22,900	....	17,940	·90	16,100	·80	21,660	20	24,140
21	161·49	26,000	·89	22,280	....	17,940	160·00	16,700	160·90	22,280	161·30	24,760
22	·09	23,520	·89	22,280	....	17,320	159·90	16,100	·90	22,280	·25	24,450
23	....	23,210	·99	22,900	....	17,320	160·00	16,700	161·00	22,900	·25	24,450
24	160 99	22,900	·59	22,900	160·09	17,320	·00	16,700	·00	22,900	·30	24,760
25	....	22,900	161·09	23,520	·09	17,320	·00	16,700	·10	23,520	·30	24,760
26	....	22,900	·09	23,520	160·09	17,320	160·00	16,700	161·10	23,520	161·30	24,760
27	....	22,900	160·99	22,900	·09	17,320	·00	16,700	·10	23,520	·25	24,450
28	....	22,900	9·9	22,900	·09	17,320	·00	16,700	·10	23,520	·25	24,450
29	....	22,900	....	....	·09	17,320	·00	16,700	·10	23,520	·30	24,760
30	....	22,900	....	....	·09	17,320	·08	16,700	·20	24,140	·30	24,760
31	....	22,900	....	....	159·99	16,700	....	....	·20	24,140	....	....

No. 14.

Winnipeg River, near Otter Falls, for 1909.

Day.	July.		August.		September.		October.		November.		December.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght.	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	161 25	24,450	161·25	21,450	161·10	23,520	160·80	21,660	160·50	19,800	160·70	21,940
2	·25	24,450	·25	24,450	·00	22,900	·75	21,350	·45	19,490	·75	21,350
3	·30	24,760	·20	21,140	·00	22,900	·75	21,350	·50	19,800	·75	21,350
4	·30	24,760	·20	24,140	·00	22,900	·75	21,350	·55	20,110	·75	21,350
5	·30	27,760	·20	24,140	·05	23,210	·75	21,350	·55	20,110	75	21,350
6	161·30	24,760	161·30	24,760	161·00	22,900	160·75	21,350	160 55	20,110	160·75	21,350
7	35	25,070	·30	21,760	160·90	22,280	·75	21,350	·55	20,110	·75	21,350
8	·35	25,070	·30	24,760	·95	22,590	·70	21,040	·55	20,110	·80	21,660
9	·35	25,070	·50	24,760	·85	21,970	·65	20,730	·55	20,110	·85	21,970
10	·35	25,070	·30	24,760	·90	22,280	·60	20,420	·55	20,110	·95	22,590
11	161·30	24,760	161·25	24,450	160·90	22,280	160·55	20,110	160·55	20,110	160·95	22,590
12	·30	21,760	·25	21,450	·90	22,280	·55	20,110	·55	20,110	·95	22,590
13	·30	24,760	·30	24,760	·95	22,590	·50	19,800	·60	20,420	95	22,590
14	·30	21,760	·35	25,070	·95	22,590	·50	19,800	·60	20,420	·95	22,590
15	·30	24,760	·35	25,070	·90	22,280	·50	19,800	·60	20,420	·95	22,590
16	161·30	24,760	161·35	25,070	160·90	22,280	160·50	19,800	160 60	20,420	160 95	22,590
17	·30	24,760	·30	24,760	·90	22,280	·45	19,490	·60	20,420	·95	22,590
18	·30	24,760	·30	24,760	·95	22,590	·50	19,800	·65	20,730	·95	22,590
19	·30	24,760	·30	21,760	·90	22,280	·55	20,110	·65	20,730	·95	22,590
20	·30	24,760	·20	21,140	·90	22,280	·55	20,110	·65	20,730	·95	22,590
21	161·30	24,760	161·25	24,450	160·85	21,970	160·50	19,800	160·65	20,730	160·95	22,590
22	·30	24,760	·25	21,450	·85	21,970	·55	20,110	·65	20,730	·95	22,590
23	·30	24,760	·25	24,450	·85	21,970	·55	20,110	·70	21,040	·95	22,590
24	·30	24,760	·25	24,450	·80	21,660	·55	20,110	·70	21,040	161·00	22,900
25	·25	24,450	·25	24,450	·80	21,660	·55	20,110	·70	21,040	·00	22,900
26	161·20	24,140	161·25	24,450	160·80	21,660	160·50	19,800	160·70	21,040	161·00	22,900
27	·25	24,450	·30	21,760	·80	21,660	·45	19,490	·70	21,040	·05	23,210
28	·20	24,140	·30	24,760	·80	21,660	·55	20,110	·70	21,010	·20	24,140
29	·20	21,140	·25	24,450	·80	21,660	·55	20,110	·70	21,040	·35	25,070
30	·15	23,830	·15	23,830	·80	21,660	·50	19,800	·70	21,040	·20	24,140
31	·20	24,140	·10	23,520	... .	....	·50	19,800	....	......	·20	24,140

TABLE

Daily Gauge Height and Discharge of

Day.	January. Gauge Height.	January. Dis-charge.	February. Gauge Height.	February. Dis-charge.	March. Gauge Height.	March. Dis-charge.	April. Gauge Height.	April. Dis-charge.	May. Gauge Height.	May. Dis-charge.	June. Gauge H'ght.	June. Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	161·20	24,140	161·30	24,760	161·20	24,140	161·40	25,380	165·50	50,880	165·70	52,160
2	·20	24,140	·30	24,760	·20	24,140	·50	26,000	·55	51,200	·65	51,840
3	·20	24,140	·30	24,760	·20	24,140	·60	26,620	·70	52,160	·60	51,520
4	·50	26,000	·30	24,760	·20	24,140	·70	27,240	·75	52,480	·55	51,200
5	·35	25,070	·30	24,760	·20	24,140	·90	28,480	·80	52,800	·60	51,520
6	161·40	25,380	161·30	24,760	161·20	24,140	162·20	30,340	165·85	53,120	165·65	51,840
7	·40	25,380	·25	24,450	·20	24,140	·40	31,580	·90	53,440	·65	51,840
8	·50	26,000	·20	24,140	·20	24,140	·60	32,820	·85	53,120	·65	51,840
9	·70	27,240	·20	24,140	·20	24,140	·80	34,060	·80	52,800	·65	51,840
10	·50	26,000	·20	24,140	·20	24,140	163·10	35,920	·80	52,800	·65	51,840
11	161·50	26,000	161·20	24,140	161·20	24,140	·30	37,160	165·80	52,800	165·60	51,520
12	·50	26,000	·20	24,140	·20	24,140	·50	38,400	·80	52,800	·50	50,880
13	·50	26,000	·20	24,140	·15	23,830	·60	39,020	·80	52,800	·45	50,560
14	·50	26,000	·20	24,140	·15	23,830	·75	39,950	·80	52,800	·35	49,920
15	·50	26,000	·20	24,140	·15	23,830	·90	40,880	·85	53,120	·25	49,280
16	161·45	25,690	161·20	24,140	161·15	23,830	164·00	41,500	165·90	53,440	165·15	48,650
17	·40	25,380	·20	24,140	·15	23,830	·15	42,430	·85	53,120	·05	48,020
18	·40	25,380	·20	24,140	·15	23,830	·40	43,980	·85	53,120	164·95	47,390
19	·35	25,070	·20	24,140	·15	23,830	·55	44,910	·85	53,120	·85	46,770
20	·35	25,070	·20	24,140	·15	23,830	·75	46,150	·85	53,120	·85	46,770
21	161·35	25,070	161·20	24,140	161·15	23,830	164·75	46,150	165·85	53,120	164·80	46,460
22	·20	24,760	·20	24,140	·15	23,830	·75	46,150	·85	53,120	·80	46,460
23	·35	25,070	·20	24,140	·15	23,830	·85	46,770	·85	53,120	·75	46,150
24	·35	25,070	·20	24,140	·15	23,830	165·00	47,700	·85	53,120	·75	46,150
25	·35	25,070	·20	24,140	·10	23,520	·20	48,960	·80	52,800	·70	45,840
26	161·30	24,760	161·20	24,140	161·05	23,210	165·25	49,280	165·80	52,800	164·65	45,530
27	·30	24,760	·20	24,140	·00	22,900	·30	49,600	·80	52,800	·55	44,910
28	·30	24,760	·20	24,140	·00	22,900	·30	49,600	·85	53,120	·50	44,600
29	·30	24,760	....	....	·05	23,210	·30	49,600	·85	53,120	·40	43,980
30	·30	24,760	....	....	·05	23,210	·40	50,240	·80	52,800	·30	43,360
31	·20	24,140	....	....	·20	24,140	....	....	·75	52,480	.....	.....

No. 15.

Winnipeg River, near Otter Falls, for 1910.

Day.	July.		August.		September.		October.		November.		December.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	164·25	43,050	161·80	27,800	160·80	21,660	160·25	18,250	159·78	15,500	159·38	13,450
2	·20	42,740	·90	28,480	·80	21,660	·20	17,940	·74	15,180	·35	13,250
3	·20	42,740	·65	26,930	·70	21,040	·20	17,940	·74	15,180	·35	13,250
4	·15	42,430	·60	26,620	·70	21,040	·25	18,250	·70	14,950	·35	13,250
5	·10	42,120	·55	26,310	·70	21,040	·15	17,630	·70	14,950	·30	13,050
6	164.00	41,500	161·60	26,620	160·70	21,040	160·20	17,940	159·70	14,950	159·30	13,050
7	·00	41,500	·55	26,310	·65	20,730	·20	17,940	·70	14,950	·30	13,050
8	163 90	40,880	·50	26,000	·50	19,800	·20	17,940	·70	14,950	·30	13,050
9	·90	40,880	·45	25,690	·45	19,490	·20	17,940	·65	14,630	·30	13,050
10	·90	40,880	·50	26,000	·45	19,490	·20	17,940	·60	14,400	·30	13,050
11	163·85	40,570	161·45	25,690	160·50	19,800	160·15	17,630	159·60	14,400	159·30	13,050
12	·75	39,950	·40	25,380	·40	19,180	·15	17,630	·65	14,630	·30	13,050
13	·70	39,640	·35	25,070	·45	19,490	·05	17,010	·65	14,630	·30	13,050
14	·70	39,640	·35	25,070	·40	19,180	·00	16,700	·60	14,400	·30	13,050
15	·60	39,020	·35	25,070	·40	19,180	·00	16,700	·50	13,900	·20	12,700
16	163·55	38,710	161·35	25,070	160·40	19,180	160·05	17,010	159·44	13,680	159·20	12,700
17	·40	37,780	·40	25,380	·35	18,870	·00	16,700	·50	13,900	·20	12,700
18	·25	36,850	·15	23,830	·40	19,180	·00	16,700	·40	13,450	·20	12,700
19	·10	35,920	·30	24,760	·45	19,490	·05	17,010	·50	13,900	·20	12,700
20	·09	35,300	·00	22,900	·40	19,180	·05	17,010	·55	14,150	·25	12,880
21	165·85	34,370	161·15	23,830	160·30	18,560	160·10	17,320	159·50	13,900	159 25	12,880
22	·65	33,130	·00	22,900	·35	18,870	·00	16,700	·45	13,680	·18	12,700
23	·55	32,510	·15	23,830	·35	18,870	159·95	16,400	·40	13,450	·14	12,550
24	·50	32,200	·10	23,520	·40	19,180	·90	16,100	·50	13,900	·12	12,400
25	·50	32,200	·00	22,900	·40	19,180	·90	16,100	·50	13,900	·10	12,400
26	162·45	31,890	160·95	22,590	160·10	19,180	159·90	16,100	159·50	13,900	159·10	12,400
27	·35	31,270	·90	22,280	·40	19,180	·87	15,800	·50	13,900	·20	12,700
28	·25	30,650	·90	22,280	·30	18,560	·85	15,800	·50	13,900	·15	12,550
29	·05	29,410	·90	22,280	·35	18,870	·85	15,800	·45	13,680	·30	13,050
30	161·85	28,170	·90	22,280	·35	18,870	·82	15,500	·42	13,450	·35	13,250
31	·75	27,550	·85	21,970	......	......	·80	15,500	......	......	·40	13,450

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE of

Day.	January.		February.		March.		April.		May.		June.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght.	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	159·50	13,800	159·50	13,800	159·42	13,350	159·00	12,000	159·25	12,780	160·10	16,860
2	·58	14,300	·54	14,050	·30	12,950	158·90	11,700	·30	12,950	·15	17,140
3	·66	14,550	·58	14,300	·30	12,950	159·00	12,000	·30	12,950	·20	17,420
4	·78	15,300	·46	13,580	·30	12,950	·10	12,300	·30	12,950	·20	17,420
5	·72	14,800	·55	14,050	·35	13,150	·08	12,300	·35	13,150	·20	17,420
6	159·70	14,800	159·65	14,550	159·38	13,350	159·02	12,000	159·40	13,350	160·20	17,420
7	·70	14,800	·54	14,050	·42	13,350	·02	12,000	·45	13,580	·20	17,420
8	·70	14,800	·42	13,350	·20	12,600	·02	12,600	·40	13,350	·20	17,420
9	·71	14,800	·48	13,800	·15	12,450	·02	12,000	·45	13,580	·25	17,700
10	·75	15,050	·50	13,800	·18	12,600	·00	12,000	·47	13,580	·25	17,700
11	159·80	15,300	159·48	13,800	159·00	12,000	159·00	12,000	159·48	13,800	160·30	17,980
12	·95	16,050	·40	13,350	·40	13,350	·05	12,150	·50	13,800	·35	18,260
13	160·00	16,300	·32	12,950	12	12,300	·05	12,150	·50	13,800	·35	18,260
14	·05	16,580	·23	12,780	·18	12,600	·05	12,150	·60	14,300	·35	18,260
15	·10	16,860	·23	12,780	·14	12,450	·12	12,300	·70	14,800	·35	18,260
16	160·15	17,140	159·23	12,780	159·14	12,450	159·15	12,450	159·77	15,056	160·35	18,260
17	·00	16,300	·23	12,780	·14	12,450	·15	12,450	·79	15,300	·38	18,540
18	159·78	15,300	·25	12,780	·12	12,300	·17	12,450	·85	15,550	·36	18,260
19	·76	15,050	·28	12,950	·10	12,300	·17	12,450	·87	15,550	·40	18,540
20	·72	14,800	·30	12,950	·08	12,300	·17	12,450	·90	15,800	·40	18,540
21	159·68	14,800	159·30	12,950	159·05	12,150	159·25	12,780	159·90	15,800	160·39	18,540
22	·64	14,550	27	12,780	·10	12,300	·25	12,780	·88	15,800	·43	18,820
23	·62	14,300	·25	12,780	·12	12,300	·25	12,780	·90	15,800	46	18,820
24	·60	14,300	·22	12,600	·15	12,450	·25	12,780	·90	15,800	·50	19,100
25	·60	13,800	·22	12,600	·13	12,450	·25	12,780	·90	15,800	·58	19,660
26	159·40	13,350	159·25	12,780	159·00	12,000	159·27	12,780	159·95	16,050	160·60	19,650
27	·40	13,350	·30	12,950	158·90	11,700	·32	12,950	·98	16,300	·60	19,660
28	·40	13,350	·35	13,150	159·10	12,300	·31	12,950	160·02	16,300	·60	19,660
29	·45	13,580	......	......	·07	12,150	·30	12,950	·05	16,580	·62	19,660
30	·45	13,580	......	......	·15	12,450	·25	12,780	·10	16,860	·62	19,660
31	·50	13,800	......	......	·05	12,150	......	......	·10	16,860	......	......

No. 16.

Winnipeg River, near Slave Falls, for 1911.

Day.	July.		August.		September.		October.		November.		December.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	160·62	19,660	161·62	25,260	161·68	25,820	161·47	24,420	161·60	25,260	160·75	20,500
2	·62	19,660	·61	25,260	·65	25,540	·50	24,700	·57	24,980	·72	20,220
3	·64	19,940	·60	25,260	·62	25,260	·50	24,700	·55	24,980	·68	20,220
4	·66	19,940	·63	25,540	·65	25,540	·56	24,980	·50	24,700	·65	19,940
5	·66	19,940	·65	25,540	·65	25,540	·64	25,540	·45	24,420	·65	19,940
6	160·66	19,940	161·68	25,820	161·64	25,540	161·75	26,100	161·42	24,140	160·62	19,660
7	·66	19,940	·72	25,820	·60	25,260	·79	26,380	·37	23,860	·60	19,660
8	·78	20,780	·78	26,380	·55	24,980	·85	26,660	·36	23,860	·60	19,660
9	·90	21,340	·84	26,660	·48	24,700	·85	26,660	·34	23,860	·56	19,380
10	·90	21,340	·90	26,940	·45	24,420	·85	26,660	·33	23,860	·56	19,380
11	160·95	21,620	161·87	26,660	161·46	24,420	161·90	26,940	161·33	23,860	160·60	19,660
12	161·05	22,180	·85	26,660	·40	24,140	·93	27,220	·30	23,580	·60	19,660
13	·10	22,460	·85	26,660	·38	24,140	·80	26,380	·25	23,300	·60	19,660
14	·15	22,740	·85	26,660	·40	24,140	·80	26,380	·20	23,020	·55	19,380
15	·18	23,020	·85	26,660	·43	24,420	·80	26,380	·15	22,740	·55	19,380
16	161·25	23,300	161·83	26,660	161·43	24,420	161·80	26,380	161·15	22,740	160·56	19,380
17	·34	23,860	·81	26,380	·45	24,420	·65	25,540	·10	22,460	·66	19,940
18	·42	24,140	·81	26,380	·47	24,420	·70	25,820	·10	22,460	·55	19,380
19	·48	24,700	·80	26,380	·50	24,700	·75	26,100	·10	22,460	·54	19,380
20	·48	24,700	·78	26,380	·53	24,980	·75	26,100	·05	22,180	·53	19,380
21	161·52	24,700	161·77	26,100	161·56	24,980	161·78	26,380	161·05	22,180	160·52	19,100
22	·52	24,700	·75	26,100	·57	24,980	·80	26,380	·05	22,180	·50	19,100
23	·52	24,700	·76	26,100	·57	24,980	·75	26,100	·00	21,900	·50	19,100
24	·52	24,700	·76	26,100	·54	24,980	·75	26,100	161·00	21,900	·48	19,100
25	·52	24,700	·75	26,100	·51	24,700	·70	25,820	160·95	21,620	·50	19,100
26	161·55	24,980	161·75	26,100	161·48	24,700	161·70	25,820	·90	21,340	160·46	18,820
27	·60	25,260	·73	26,100	·45	24,420	·70	25,820	·90	21,340	·42	18,540
28	·62	25,260	·70	25,820	·48	24,700	·70	25,820	·88	21,340	·40	18,540
29	·62	25,260	·70	25,820	·45	24,420	·68	25,820	·85	21,060	·35	18,260
30	·62	25,260	·68	25,820	·48	24,700	·65	25,540	·80	20,780	·30	17,980
31	·62	25,260	·68	25,820	......	......	·60	25,260	....	....	·30	17,980

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE of

Day.	January.		February.		March.		April.		May.		June.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	160.30	17,980	160.40	18,540	159.85	15,550	....	12,700	....	16,500	162.05	22,780
2	.30	17,980	.40	18,540	.84	15,550	....	12,700	160.07	16,580	.15	28,340
3	.30	17,980	.35	18,260	.83	15,550	....	12,700	.10	16,860	.15	28,340
4	.35	18,260	.30	17,980	.82	15,300	159.23	12,775	.45	18,820	......	29,000
5	.40	18,540	.28	17,980	.80	15,300	23	12,775	.50	19,100	.	29,700
6	160.65	19,940	160.28	17,980	159.77	15,050	....	12,800	160.40	18,540	162.50	30,300
7	161 00	21,900	.28	17,980	.75	15,050	....	12,800	.48	19,100	.50	30,300
8	.05	22,180	.25	17,700	.72	14,800	....	12,900	.52	19,100	.55	30,580
9	.10	22,460	.23	17,700	.68	14,800	....	12,900	.65	19,940	·30	29,180
10	.10	22,460	.20	17,420	.66	14,550	....	12,900	.....	20,500	·25	28,900
11	161.10	22,460	160.15	17,140	159.64	14,550	.....	12,900	160.85	21,060	....	28,700
12	.10	22,460	.12	16,860	.62	14,300	159.29	12,950	....	21,500	......	28,400
13	.05	22,180	.10	16,860	....	14,300	......	13,000	161.00	21,900	.....	28,200
14	.05	22,180	.05	16,580	......	14,000	....	13,000	.20	23,020	....	28,000
15	.00	21,900	.02	16,300	....	14,000	....	13,000	.35	23,860	162.05	27,780
16	160.95	21,620	160.00	16,300	....	13,700	....	13,100	....	24,000	162.05	27,780
17	.70	20,220	.00	16,300	....	13,700	....	13,100	161.40	24,140	.03	27,780
18	.70	20,220	.00	16,300	....	13,400	....	13,100	.43	24,420	.15	28,340
19	.70	20,220	159.98	16,300	....	13,400	159.35	13,150	....	24,600	.01	27,500
20	.65	19,940	.97	16,050	....	13,100	....	13,200	161.50	24,700	.03	27,780
21	160·60	19,660	159.96	16,050	....	13,100	....	13,500	161.51	24,700	162.03	27,780
22	.55	19,380	.95	16,050	159.30	12,950	....	13,800	.55	24,980	.00	27,500
23	.55	19,380	.94	16,050	....	12,700	......	14,100	.62	25,260	161.95	27,220
24	.55	19,380	.93	16,050	......	12,500	....	14,400	.70	25,820	.90	26,940
25	.50	19,100	.92	15,800	159.12	12,300	....	14,700	.74	26,100	.80	26,380
26	169.45	18,820	159.91	15,800	......	12,400	....	15,000	....	26,400	161.89	26,940
27	.45	18,820	.89	15,800	......	12,400	....	15,300	161.85	26,660	.88	26,940
28	.45	18,820	.89	15,800	....	12,500	....	15,600	.88	26,940	.....	26,940
29	.43	18,820	.88	15,800	....	12,500	....	15,900	.91	26,940	.89	26,940
30	.41	18,540	......	....	......	12,600	....	16,200	.95	27,220	.87	26,660
31	.40	18,540	....	....	......	12,600	....	....	.98	27,500	.. ..	....

No. 17.

Winnipeg River, at Slave Falls, for 1912.

	July.		August.		September.		October.		November.		December.	
Day.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height	Dis-charge.	Gauge Height.	Dis-charge.	Gauge H'ght	Dis-charge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	161.96	27,220	162.05	27,780	161.99	27,500	....	30,300	163.25	34,500	162.60	30,860
2	.89	26,940	.05	27,780	.99	27,500	....	30,500	.25	34,500	.60	30,860
3	.87	26,660	.01	27,500	162.00	27,500	....	30,700	.25	34,500	.60	30,860
4	.84	26,660	.05	27,780	.47	30,020	....	3[illegible],900	.25	34,500	.60	30,860
5	.79	26,380	.09	28,060	.35	29,460	....	31,100	.20	34,220	.60	30,860
6	161.75	26,100	162.07	27,786	162.16	28,340	....	31,300	163.15	33,940	162.60	30,860
7	.76	26,100	.10	28,060	.25	28,900	162.70	31,420	.15	33,940	.50	30,300
8	.78	26,380	.05	27,780	.25	28,9[illegible]0	.70	31,420	15	33,940	.50	30,300
9	.76	26,100	.05	27,780	.26	28,900	.74	31,700	.15	33,940	.50	30,300
10	.76	26,100	.06	27,780	.25	28,900	.80	31,980	.15	33,940	.50	30,300
11	161.75	26,100	162.07	27,780	162.23	28,960	162 91	32,540	163.15	33,940	162.40	29,740
12	.76	26,100	.08	28,060	.25	28,900	.96	32,820	.10	33,660	.40	29,740
13	.76	26,10[illegible]	.04	28,060	.25	28,900	.98	33,100	.10	33,660	.40	29,740
14	75	26,100	.03	27,780	....	29,000	163.03	33,380	.00	33,100	.30	29,180
15	.77	26,100	.03	27,780	....	29,200	.05	33,380	162.96	32,540	.30	29,180
16	161.79	26,380	162.03	27,780	....	29,300	163.06	33,380	.85	32,260	162.30	29,180
17	.80	26,380	.02	27,500	....	29,500	10	33,660	.85	32,260	.20	28,620
18	.78	26,380	.04	27,780	....	29,600	.10	33,660	.85	32,260	.20	28,620
19	.75	26,100	05	27,780	....	29,800	.15	33,940	.85	32,260	.20	28,620
20	.76	26,100	161 98	27,500	....	29,900	.20	34,220	.85	32,260	.20	28,620
21	161.74	26,100	162.00	27,500	162 45	30,020	163.28	34,780	162.80	31,980	162 20	28,620
22	.70	25,820	.05	27,780	.46	30,020	.28	34,780	.80	31,9[illegible]0	.20	28,620
23	.75	26,1[illegible]0	.05	27,780	.48	38,300	.28	34,780	.80	31,980	.20	28,620
24	.77	26,100	161.98	27,500	.51	30,300	.25	34,500	.80	31,980	.20	28,620
25	.79	26,380	162.00	27,500	.58	30,860	.25	34,500	.75	31,700	.20	28,620
26	161.80	26,380	.00	27,500	162.57	30,500	163.20	34,220	162.75	31,700	162.20	28,620
27	.84	26,660	.00	27,500	.56	30,580	.20	34,220	.75	31,700	.20	28,620
28	.85	26,660	.00	27,500	.56	30,580	.20	34,220	.75	31,700	.20	28,620
29	.89	26,940	161.99	27,500	.46	30,020	.25	34,500	.75	31,700	.20	28,620
30	.90	26,940	162.00	27,500	....	30,100	.25	24,500	.75	31,700	.10	28,060
31	.94	27,220	.00	27,500	....	....	.30	34,780	....	....	.10	28,060

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE of

Day.	January.		February.		March.		April.		May.		June.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge H'ght	Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	162·1	28,060	162 1	28,060	160·9	21,340	159·9	15,500	160·89	21,340	162·81	31,980
2	0	27,500	·1	28,060	·9	21,340	·95	16,050	161·11	22,460	·94	32,820
3	·0	27,500	·1	28,060	·9	21,340	·95	16,050	·18	23,020	·89	32,540
4	·0	27,500	·1	28,060	·8	20,780	160·0	16,300	·27	23,300	·96	32,820
5	·0	27,500	·1	28,060	·8	20,780	·0	16,300	·51	24,700	163·00	33,100
6	162·0	27,500	162·1	28,060	160·8	20,780	160·0	16,300	161·61	25,260	162·93	32,820
7	·0	27,500	·1	28,060	·8	20,780	·0	16,300	·72	25,820	·96	32,820
8	·0	27,500	0	27,500	·7	20,220	·0	16,300	·70	25,820	·92	32,540
9	·0	27,500	·0	27,500	·7	20,220	·0	16,300	·82	26,380	163·03	33,380
10	·0	27,500	·0	27,500	·6	19,660	·0	16,300	·89	26,940	·02	33,100
11	162·0	27,500	162·0	27,500	160 6	19,660	160·05	16,580	161·98	27,500	163·05	33,380
12	·1	28,060	·0	27,500	·5	19,100	·05	16,580	162·03	27,780	·05	33,380
13	·1	28,060	·0	27,500	·5	19,100	·05	16,580	·03	27,780	·11	33,660
14	·1	28,060	·0	27,500	·5	19,100	·05	16,580	·10	28,060	·05	33,380
15	·1	28,060	161·9	26,940	·4	18,540	·05	16,580	·11	28,060	162·94	32,820
16	162·1	28,060	·9	26,940	160·4	18,540	160·1	16,860	162·14	28,340	163·01	33,100
17	·1	28,060	·8	26,380	·4	18,540	·1	16,860	·12	28,060	·02	33,100
18	·1	28,060	·8	26,380	·3	17,980	·15	17,140	·15	28,340	162·99	33,100
19	·1	28,060	·6	25,260	·3	17,980	·15	17,140	·37	29,460	·94	32,820
20	·1	28,060	·6	25,260	·3	17,980	·2	17,420	·43	30,020	·90	32,540
21	162·1	28,060	161·3	23,580	160·2	17,420	160·2	17,420	162·43	30,020	162·88	32,540
22	·1	28,060	·3	23,580	·2	17,420	·3	17,980	·43	30,020	·87	32,260
23	·1	28,060	·2	23,020	·1	16,860	·3	17,980	·68	31,420	·95	32,820
24	·1	28,060	·1	22,460	·1	16,860	·4	18,540	·70	31,420	·96	32,820
25	·1	28,060	·1	22,460	·1	16,860	·5	19,100	·78	31,980	85	32,260
26	162·1	28,060	161·0	21,900	160·1	16,860	160·5	19,100	162·80	31,980	162·86	32,260
27	·1	28,060	·0	21,900	·1	16,860	·6	19,660	·76	31,700	·85	32,260
28	1	28,060	·0	21,900	·1	16,860	·7	20,220	·88	32,540	·92	32,540
29	·1	28,060	....	....	·0	16,300	·7	20,220	·86	32,260	·85	32,260
30	·1	28,060	....	....	0	16,300	·7	20,220	·83	32,260	·91	32,540
31	·1	28,060	....	....	159·9	15,800	....	....	·86	32,260	.....	.....

No. 18.

Winnipeg River, near Slave Falls, for 1913.

Day.	July.		August.		September.		October.		November.		December.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge H'ght	Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	162·89	32,540	161·90	26,940	161·84	26,660	161·03	22,180	159·80	15,300	159·89	15,800
2	·93	32,820	·90	26,940	·80	26,380	160·93	21,620	·60	14,300	·82	15,300
3	·91	32,540	·87	26,660	·81	26,380	·75	20,500	70	14,800	·82	15,300
4	·91	32,540	162·00	27,500	·80	26,380	·59	19,660	·70	14,800	·77	15,050
5	·82	31,980	161·94	27,220	·77	26,100	62	19,660	·91	15,800	·79	15,300
6	162·75	31,700	·98	27,500	161·70	25,820	160·70	20,220	159·87	15,550	159·77	15,050
7	81	31,980	160·02	27,500	60	25,260	·42	18,540	·84	15,550	·54	14,050
8	·72	31,420	·01	27,500	·77	26,100	·45	18,820	·84	15,550	·82	15,300
9	·71	31,420	·02	27,500	·76	26,100	·46	18,820	·84	15,550	·76	15,050
10	·73	31,700	161·97	27,220	·70	25,820	·45	18,820	....	15,550	·79	15,300
11	162·80	31,980	162·07	27,780	161·62	25,260	160·32	17,980	....	15,500	159·74	15,050
12	·68	31,420	·09	28,060	·66	25,510	·16	17,140	....	15,450	·69	14,800
13	·52	30,300	·12	28,060	·62	25,260	·32	17,980	....	15,450	·72	14,800
14	·52	30,300	·07	27,780	·54	24,980	·27	17,700	....	15,450	·56	14,050
15	·51	30,300	·16	28,340	·61	25,260	·19	17,420	....	15,350	·59	14,500
16	162·37	29,460	162·13	28,340	161·59	25,260	160·19	17,420	159·79	15,300	159·59	14,300
17	·24	28,900	·09	28,060	·58	25,260	·16	17,140	....	15,250	·64	14,550
18	·11	28,060	·20	28,620	·63	25,540	·06	16,580	....	15,200	·56	14,050
19	·07	27,780	·19	28,620	·48	24,700	159·65	14,550	....	15,150	·56	14,050
20	161·99	27,500	·14	28,340	·43	24,420	160·02	16,300	....	15,150	·45	13,800
21	·98	27,500	162·06	27,780	161·36	23,860	160·07	16,580	....	15,050	159·49	13,800
22	162·00	27,500	·05	27,780	·58	25,260	·02	16,300	....	15,000	·46	13,570
23	161·94	27,220	161·98	27,500	·53	24,980	·02	16,300	159·69	14,800	·49	13,800
24	·90	26,940	·96	27,220	·48	24,700	·00	16,300	....	15,000	·59	14,300
25	·93	27,220	·95	27,220	·40	24,140	159·78	15,300	....	15,100	·41	13,570
26	161·82	26,380	161·92	26,940	161·35	23,860	159·99	16,300	....	15,300	159·39	13,350
27	·72	25,820	·92	26,940	·25	23,300	160·60	19,660	159·84	15,550	·32	12,950
28	·85	26,660	·88	26,940	16	22,740	10	16,860	·86	15,55	·38	13,350
29	·89	26,940	·85	26,660	·24	23,300	·10	16,860	·82	15,300	·51	13,800
30	·88	26,940	·85	26,660	13	22,740	160·00	16,300	·64	14,550	·54	14,050
31	·89	26,940	·78	26,380	....	....	·00	16,300	....	....	·51	13,800

TABLE No. 19.

MONTHLY DISCHARGE of Winnipeg River at Otter Falls, for 1907.

(Drainage area, 53,000 square miles.)

Month.	Discharge in Second-Feet.				Run-Off.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.
January	28,170	26,000	26,900	·509	·17
February	29,100	18,560	22,880	·432	·45
March	19,180	15,500	17,320	·327	·38
April	16,700	14,400	14,590	275	·31
May	20,420	14,400	16,290	·307	·35
June	33,440	21,660	28,030	·529	·59
July	34,060	30,340	32,020	·604	·70
August	34,060	30,340	31,340	591	·68
September	39,020	34,680	37,140	·701	·78
October	43,980	39,020	42,520	·802	·92
November	42,740	42,120	12,680	·805	·90
December	42,740	36,540	39,500	·745	·88
The year	43,980	14,400	29,460	·556	7·09

NOTE.—These discharges were obtained by using the gauge heights recorded at the municipal power plant, city of Winnipeg, Pointe du Bois, Man., together with the discharge measurements taken by Pratt and Ross for the Street Railway Co., at Otter falls.

Gauge readings were commenced at Pointe du Bois on January 23, 1907, and hence, the discharge given for January, 1907, applies only for nine days, and the year period is for 343 days.

TABLE No. 20.

MONTHLY DISCHARGE of Winnipeg River at Otter Falls, for 1908.

(Drainage area, 53,000 square miles)

Month.	Discharge in Second-Feet.				Run-off.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.
January	40,260	35,300	36,880	·696	·80
February	40,880	32,820	36,650	·692	·75
March	33,440	28,480	31,380	·592	·68
April	29,100	27,240	28,500	·538	·60
May	37,780	29,100	32,600	615	·71
June	45,980	38,400	41,640	·786	·88
July	43,980	41,500	42,980	·811	·94
August	41,500	37,780	39,560	·747	86
September	39,020	33,440	35,900	·677	76
October	34,680	30,340	33,040	·623	72
November	30,340	25,380	28,400	·536	·60
December	24,760	21,660	23,340	·440	·51
The year	43,980	21,660	34,230	·646	8·81

NOTE.—These discharges were obtained by using the gauge heights recorded at the municipal power plant, city of Winnipeg, Pointe du Bois, Manitoba, together with the discharge measurements taken by Pratt and Ross for the Street Railway Co. at Otter falls.

TABLE No. 21.

Monthly Discharge of Winnipeg River at Otter Falls, for 1909.

(Drainage area, 53,000 square miles.)

Month	Discharge in Second-Feet. Maximum.	Minimum.	Mean.	Run-Off. Per square mile.	Depth in inches on drainage area.
January	28,480	22,280	24,770	·467	·54
February	26,620	22,280	24,180	·456	·48
March	22,280	16,700	18,820	·355	·41
April	17,320	16,100	16,700	·315	·35
May	24,140	16,100	20,360	·383	·44
June	24,760	24,140	24,560	·463	·52
July	25,070	23,830	24,650	·465	·54
August	25,070	23,520	24,530	·463	·53
September	23,520	21,660	22,290	·420	·47
October	21,660	19,490	20,330	·384	·44
November	21,040	19,490	20,470	·386	·43
December	25,070	21,040	22,530	·425	·49
The year	28,480	16,100	22,010	·415	5·61

Note—These discharges were obtained by using the gauge heights recorded at the municipal power plant city of Winnipeg, Pointe du Bois, Man., together with the discharge measurements taken by Pratt and Ross, for the Street Railway Co. at Otter falls.

TABLE No. 22.

Monthly Discharge of Winnipeg River at Otter Falls for 1910.

(Drainage area, 53,000 square miles.)

Month.	Discharge in Second-Feet. Maximum.	Minimum	Mean.	Run-Off. Per square mile.	Depth in inches on Drainage Area.
January	27,240	24,140	25,260	·477	·55
February	24,760	24,140	24,280	·458	·48
March	24,140	22,900	23,830	·450	·52
April	50,240	25,380	39,900	·753	·84
May	53,440	50,880	52,820	·997	1·15
June	52,160	43,360	48,690	·919	1·03
July	43,050	27,550	36,950	·697	·80
August	28,480	21,970	24,700	·466	·54
September	21,660	18,560	19,630	·370	·41
October	18,250	15,500	17,000	·321	·37
November	15,500	13,450	14,280	·270	·30
December	13,450	12,400	12,920	·244	·28
The year	53,440	12,400	28,360	535	7·27

Note—These discharges were obtained by using the gauge heights recorded at the municipal power plant, city of Winnipeg, Pointe du Bois, Man., together with the discharge measurements taken by Pratt and Ross, for the Street Railway Co. at Otter falls.

TABLE No. 23.

MONTHLY DISCHARGE of Winnipeg River, at Slave falls for 1911.

(Drainage area, 52,000 square miles.)

Month.	Discharge in Second-Feet.				Run-Off.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on Drainage area.
January	17,140	13,350	14,820	·285	·33
February	14,550	12,600	13,280	·255	·27
March	13,350	11,700	12,540	·241	·28
April	12,950	11,700	12,390	·238	·27
May	16,860	12,780	14,770	·284	·33
June	19,660	16,860	18,340	·353	·39
July	25,260	19,660	22,900	·440	·51
August	26,940	25,260	26,130	·503	·58
September	25,820	24,140	24,810	·477	·53
October	27,220	24,420	25,960	·499	·57
November	25,260	20,780	22,950	·441	·49
December	20,500	17,980	19,330	·372	·43
The year	27,220	11,700	19,060	·36	4·98

NOTE.—These discharges were obtained by using the gauge heights recorded at the municipal power plant, Pointe du Bois, together with the discharge measurements taken by the Manitoba Hydrographic Survey at Slave falls.

TABLE No. 24.

MONTHLY DISCHARGE of Winnipeg River, at Slave Falls, for 1912.

(Discharge area, 52,000 square miles.)

Month.	Discharge in Second-Feet.				Run-Off.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on Drainage area.
January	22,460	17,980	20,080	·386	·445
February	18,540	15,800	16,840	·324	·350
March	15,550	12,300	13,820	·266	·307
April	16,200	12,700	13,570	·261	·291
May	27,500	16,500	22,800	·439	·506
June	30,580	26,380	28,100	·540	·602
July	27,220	25,820	26,380	·507	·585
August	28,060	27,500	27,710	·533	·617
September	30,860	27,500	29,410	·566	·631
October	34,780	30,300	33,070	·636	·735
November	34,500	31,700	32,610	·627	·700
December	30,860	28,060	29,400	·565	·652
The year	34,780	12,300	24,510	·471	6·446

NOTE.—These discharges were obtained by using the gauge heights recorded at the municipal power plant, Pointe du Bois, together with the discharge measurements taken by the Manitoba Hydrographic Survey at Slave falls.

For the year 1912, stop logs were in place in the Norman Dam at the western outlet of the Lake of the Woods until October 4, 1912, when twenty stop logs were removed. On October 17, 1912, ten more logs were removed. These thirty logs remained out throughout the balance of the year. The Head-race Mill 'A,' Keewatin, was closed from June 22nd. to November 22nd., 1912.

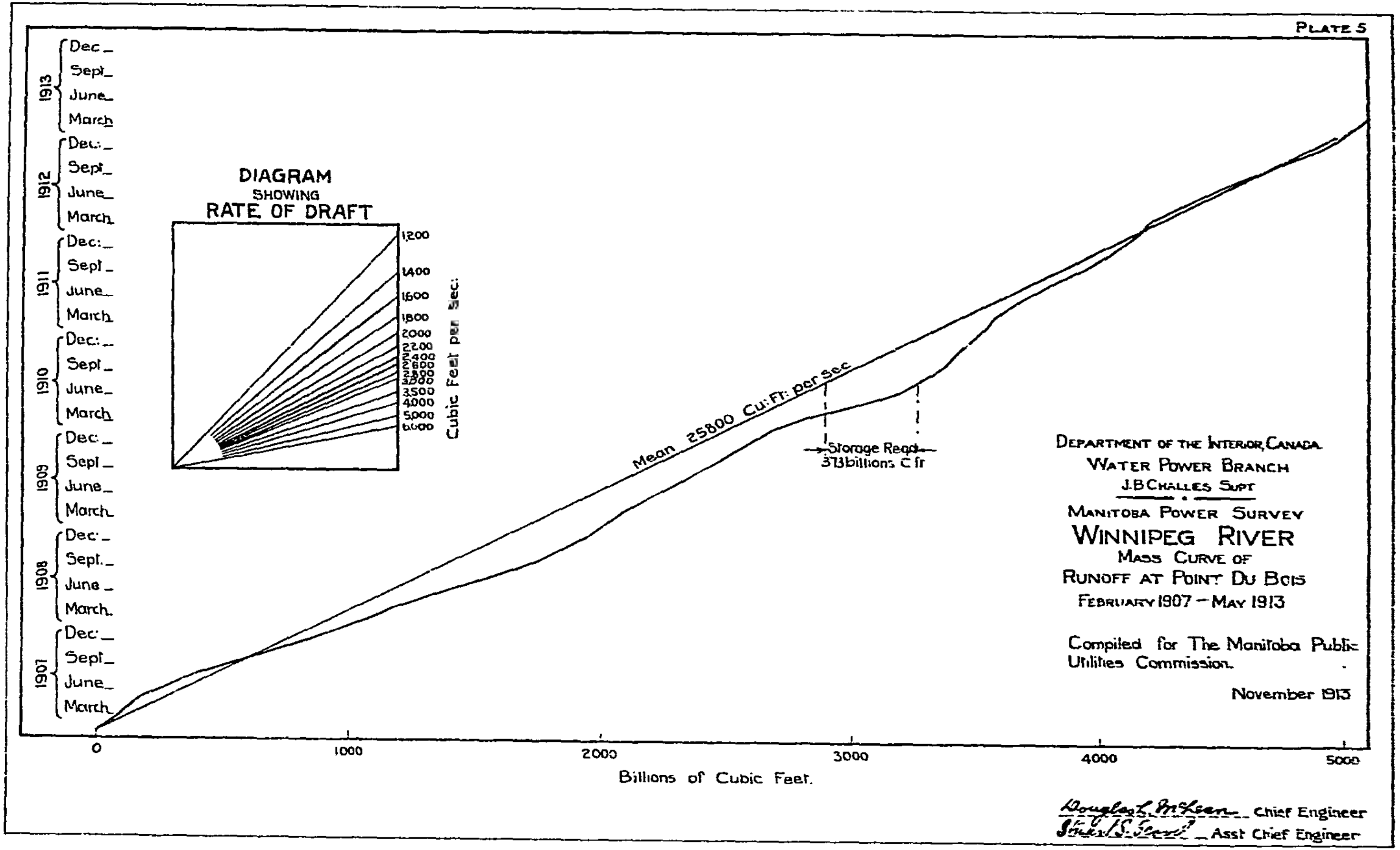


PLATE 5
DIAGRAM
SHOWING
RATE OF DRAFT
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
3,500
4,000
5,000
6,000
Cubic Feet per Sec:
1913
1912
1911
1910
1909
1908
1907
Dec
Sept
June
March
Mean 25800 Cu: Ft: per Sec
Storage Reqd
373 billions C ft
0
1000
2000
3000
4000
5000
Billions of Cubic Feet.
DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES SUPT
MANITOBA POWER SURVEY
WINNIPEG RIVER
MASS CURVE OF
RUNOFF AT POINT DU BOIS
FEBRUARY 1907 — MAY 1913
Compiled for The Manitoba Public Utilities Commission.
November 1913
Douglas L. McLean Chief Engineer
Asst Chief Engineer

5.—Existing Power Plants.

(a) *Winnipeg Electric Railway Co.*

The Winnipeg Electric Railway Company's development is situated some sixty miles from Winnipeg on the Pinawa or Lee channel. This channel is an old high-water channel of some 25 miles in length, which has been improved and is being further enlarged. The water for the plant is turned into the Pinawa channel by three diversion dams, the main of which consists of 1,332 feet of concrete-capped rock-fill across the main channel, connected with the banks on either side by concrete spillways, bringing the total length to 1,650 feet. Two small weirs of timber crib type span secondary channels. The water thus diverted flows down the improved channels to a control dam which is capable of shutting off the flow and returning a portion or all of it to the main river over the waste or diversion weir. From the control dam the water flows through the tortuous bed of the old high-water channel, the same having been deepened and partially straightened by excavation. This waterway, while at present capable of carrying in summer some 10,000 second-feet, is only able in winter, on account of the ice, to deliver about two-thirds of this amount. Below the power-house the tail-race has been improved by dredging and excavation. The power-house is situated at a bend in the river, where a concrete dam with arched spillway creates a thirty-nine foot head. The headworks are equipped with débris boom, ice-run, spillway, trash-racks and head gates. The electrical units of this plant consist of: Four 1,000 k.w. and five 2,000 k.w. revolving field, 60 cycle, 2,300 volt, three phase generators, together with two 125 k.w. direct current exciters. The generators are capable of carrying a 50 per cent overload, giving in all a total output of 21,000 k.w. or 28,200 horse-power. When 21,000 k.w. are available at this plant for peak loads, an additional 9,000 can be obtained from an auxiliary steam turbine station at Winnipeg, operated by the company. The electric energy is transmitted to the city of Winnipeg at 60,000 volts over a 65-mile transmission line.

(b) *City of Winnipeg Municipal Plant.*

The municipal power development of the city of Winnipeg is situated some seventy-seven miles northeast from Winnipeg at Pointe du Bois on the Winnipeg river. This plant consists essentially of a large concrete power station, with retaining walls and spillways forming the forebay, the entrance to which is controlled by a stoplog sluiceway type of headgate. Two concrete weirs or spill dams control the elevation of the head-waters, and, together with a rock-fill dam, divert the water to the forebay for use at the power-house.

This power concentration has created a head varying from 44 to 48 feet, with a pondage of seven square miles above the plant. This pondage is a great asset during periods of peak loads.

The development is designed for an ultimate installation of 16 units, each consisting of two-runner high speed turbines rated at 5,200 horse-power for 46 feet head, and a 3-phase 3,000 kilowatt generator. The final installation would give 48,000 kilowatts, with turbines of a maximum capacity of 83,200 horse-power. As each turbine unit requires 1,250 second-feet under maximum output at a net head of 45 feet and running at 164 revolutions per minute, the total water required would be 20,000 second-feet, plus the water for the two small exciter units.

The present installation consists of five generators of 3,000 kilowatts each and two exciters of 250 kilowatts each, making a total of 15,500 kilowatts, and at a maximum load requires 7,800 second-feet.

The electric energy is transmitted to the city of Winnipeg at 66,000 volts over a 77-mile transmission line, built on a municipally-owned 100-foot right of way. The conductors are of aluminum, supported on steel towers throughout. A duplicate line is now under consideration.

6.—Basis of Discussion on Government Power Proposals.

The cost estimates for the Government power proposals on the Winnipeg river refer in all cases to the capital cost of installation, and are based on both initial and final development. The initial development is designed to utilize at each site the present minimum flow of the river, *i.e.*, 12,000 second-feet, or such portion of it as may be available at the particular site in question. The final development is designed to utilize at each site, a regulated flow of 20,000 second-feet, or such portion of it as may be available at the site. After the diversion of sufficient water into the Pinawa channel to properly operate the plant of the Winnipeg Electric Railway Company, there would remain for use at Seven Sisters, in the main river, about 4,000 and 12,000 second-feet under unregulated and regulated conditions of the river, respectively. It is important to note that it is on this basis that the available power of the Seven Sisters sites is discussed.

In order that the power sites could be compared on a rational and equitable basis, all the layouts and designs have been standardized in so far as possible, giving full consideration to the varying heads, and to the local physical conditions at each individual site. No allowance has been made in the estimate for transmission, the costs being in all cases the capital cost for power on the low tension switchboard in the power-house, and the power being considered as straight 24-hour power at 75 per cent efficiency, based on the flow. This forms a very conservative basis. Transmission costs are omitted from the estimates, as it is impossible to foretell the use to which the power at the various sites may be applied when developed, and a straight comparison of the sites as they stand is desired. The costs given herewith may be slightly altered upon final revision.

In all cases the dams are designed in solid concrete, with ample discharging capacity to pass the severest floods to be anticipated. The power stations have been developed on single runner vertical turbine installations, varied for the different heads and to meet local conditions.

A continuous profile of the river to sea-level datum was run at the beginning of the field work, and forms the groundwork upon which the whole survey was developed. Recognition of the future needs of navigation has been given, and provision in the permanent work for the accommodation, if necessary, of future lockage facilities at the different sites has been made.

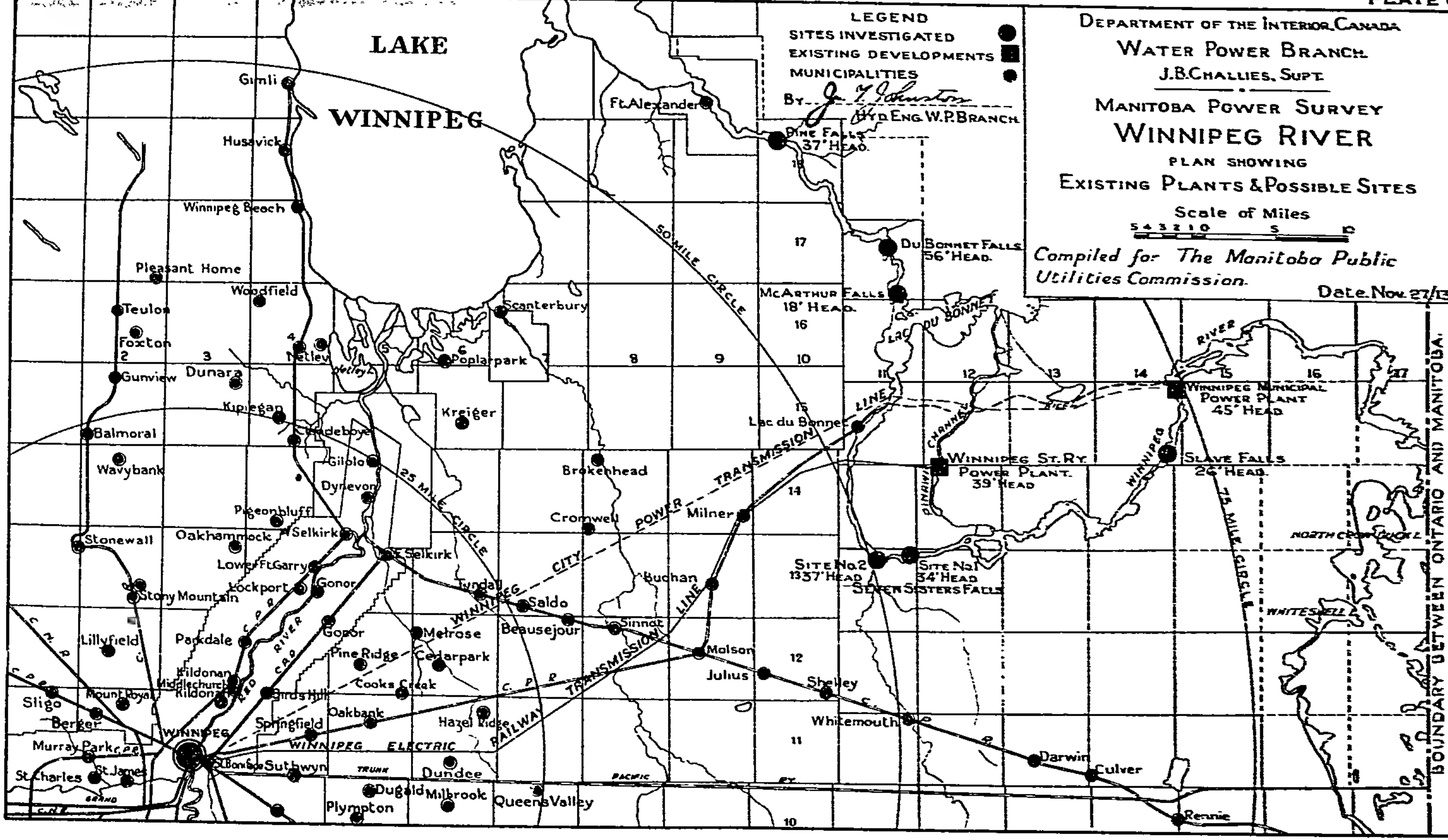
7.—Government Power Proposals.

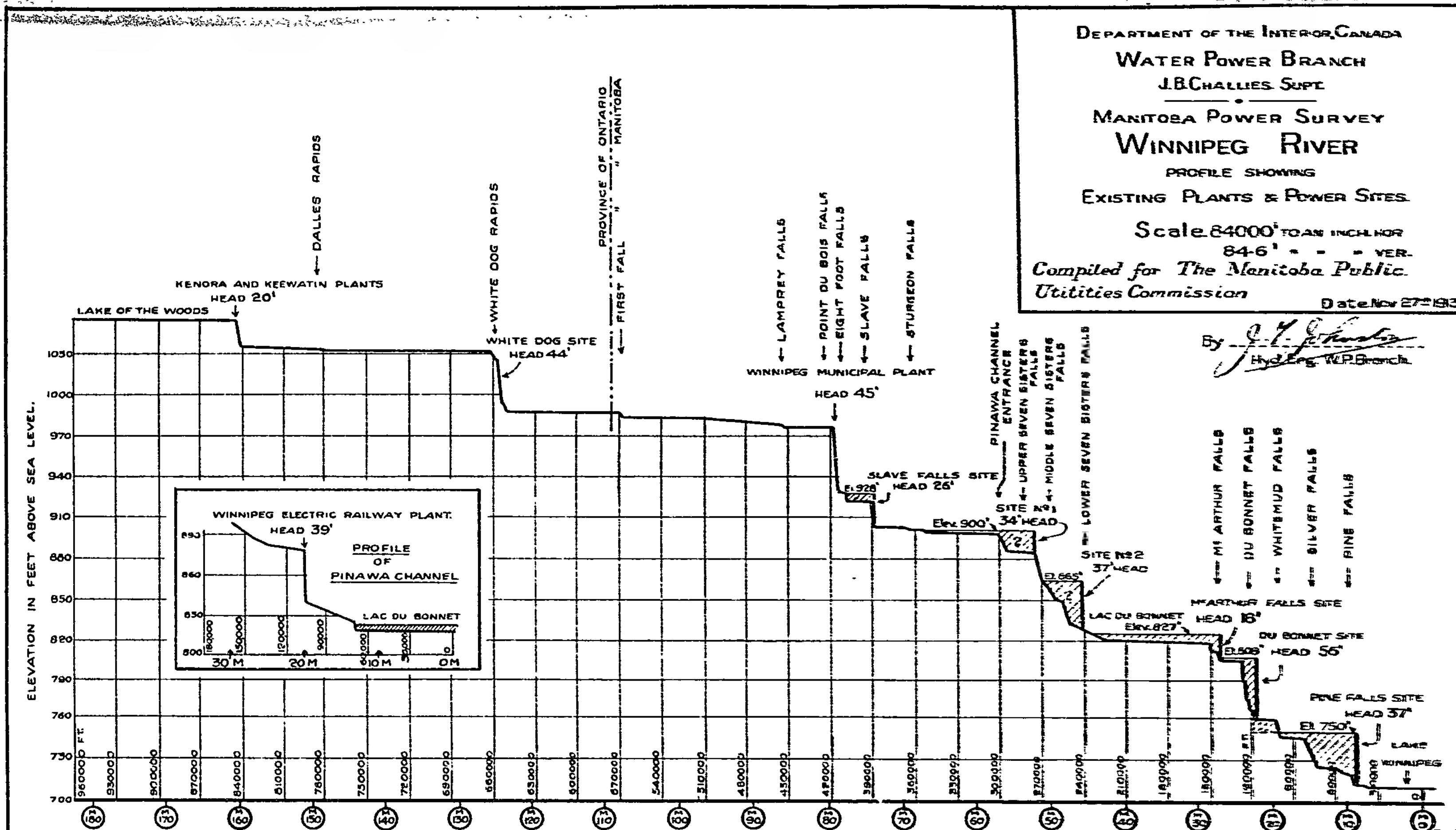
(a) Slave Falls Site.

The proposed development at Slave falls concentrates a head of 26 feet, formed by the combination of the Slave and Eight-Foot falls. The dam runs along the crest of the falls and, curving downstream through an arc of about 90 degrees, connects with the power station on the right bank of the river. Provision has been made for the future installation of a lock on the left bank.

The head and tail-water elevation, as at present proposed, are 928 and 902 respectively. The initial installation on which the estimate is made provides for eight 5,000 horse-power turbines sufficient to provide for a flow of 12,000 second-feet at 8/10 gate, with a spare machine for emergencies. On a 75 per cent efficiency, 24-hour basis, 26,000 horse-power will be available at a capital cost of $93.45 per horse-power at the low tension switchboard. The final installation provides thirteen 5,000 horse-power turbines, sufficient for a flow of 20,000 second-feet at 8/10 gate, with a spare machine. On a 75 per cent efficiency, 24-hour basis, 44,400 horse-power will be available at a cost of $83.30 per horse-power at the switchboard.

PLATE 6


DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT.
MANITOBA POWER SURVEY
WINNIPEG RIVER
PLAN SHOWING
EXISTING PLANTS & POSSIBLE SITES
Scale of Miles
5 4 3 2 1 0 5 10
Compiled for The Manitoba Public Utilities Commission.
Date Nov. 27/13.
LEGEND
SITES INVESTIGATED
EXISTING DEVELOPMENTS
MUNICIPALITIES
BY J. T. Johnston
HYD. ENG. W.P. BRANCH
LAKE WINNIPEG
50 MILE CIRCLE
25 MILE CIRCLE
75 MILE CIRCLE
PINE FALLS 37' HEAD
DU BONNET FALLS 56' HEAD
McARTHUR FALLS 18' HEAD
WINNIPEG MUNICIPAL POWER PLANT 45' HEAD
WINNIPEG ST. RY. POWER PLANT. 39' HEAD
SLAVE FALLS 26' HEAD
SITE No. 2 1337' HEAD
SITE No. 1 34' HEAD
SEVEN SISTERS FALLS
LAC DU BONNET
WINNIPEG RIVER
CITY POWER TRANSMISSION LINE
WINNIPEG ELECTRIC RAILWAY TRANSMISSION LINE
C. P. R.
C. N. R.
RED RIVER
NORTH CROSS LAKE
WHITESHELL
BOUNDARY BETWEEN ONTARIO AND MANITOBA.
Gimli
Husavick
Winnipeg Beach
Pleasant Home
Woodfield
Teulon
Foxton
Gunview
Dunara
Netley
Kipiegan
Balmoral
Wavybank
Stonewall
Oakhammock
Pigeonbluff
Selkirk
E. Selkirk
Lower Ft. Garry
Lockport
Stony Mountain
Gonor
Lillyfield
Parkdale
Kildonan
Middlechurch
Mount Royal
Sligo
Berger
Murray Park
St. Charles
St. James
WINNIPEG
St. Boniface
Suthwyn
Springfield
Birds Hill
Oakbank
Cooks Creek
Pine Ridge
Cedarpark
Melrose
Hazel Ridge
Dundee
Dugald
Milbrook
Plympton
Queens Valley
Tyndall
Saldo
Beausejour
Sinnat
Buchan
Molson
Julius
Shelley
Whitemouth
Darwin
Culver
Rennie
Milner
Cromwell
Brokenhead
Kreiger
Poplarpark
Scanterbury
Clandeboye
Gilolo
Dynevor
Ft. Alexander
Lac du Bonnet


DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES SUPT.
MANITOBA POWER SURVEY
WINNIPEG RIVER
PROFILE SHOWING
EXISTING PLANTS & POWER SITES.
Scale 84000' TO AN INCH HOR.
84.6' " " " VER.
Compiled for The Manitoba Public Utilities Commission
Date Nov 27th 1913
By J. T. Johnston
Hyd. Eng. W.P. Branch
ELEVATION IN FEET ABOVE SEA LEVEL.
LAKE OF THE WOODS
KENORA AND KEEWATIN PLANTS
HEAD 20'
DALLES RAPIDS
WHITE DOG RAPIDS
WHITE DOG SITE
HEAD 44'
PROVINCE OF ONTARIO
" " MANITOBA
FIRST FALL
LAMPREY FALLS
POINT DU BOIS FALLS
EIGHT FOOT FALLS
SLAVE FALLS
STURGEON FALLS
WINNIPEG MUNICIPAL PLANT
HEAD 45'
SLAVE FALLS SITE
HEAD 26'
El. 928'
PINAWA CHANNEL ENTRANCE
UPPER SEVEN SISTERS FALLS
MIDDLE SEVEN SISTERS FALLS
LOWER SEVEN SISTERS FALLS
SITE No 1
34' HEAD
Elev. 900'
SITE No 2
37' HEAD
El. 865'
LAC DU BONNET
Elev. 827'
Mc ARTHUR FALLS SITE
HEAD 18'
DU BONNET SITE
HEAD 56'
El. 808'
Mt ARTHUR FALLS
DU BONNET FALLS
WHITEMUD FALLS
SILVER FALLS
PINE FALLS
PINE FALLS SITE
HEAD 37'
El. 750'
LAKE WINNIPEG
WINNIPEG ELECTRIC RAILWAY PLANT.
HEAD 39'
PROFILE OF PINAWA CHANNEL
30 M
20 M
10 M
0 M

(b) Seven Sisters Sites.

No detail work has as yet been possible covering the best method of development of this reach of the river. However, it is considered that it can ultimately be developed at two sites of about 34 and 37 feet head, respectively. After providing sufficient water for the plant of the Winnipeg Electric Railway Company on the Pinawa channel, it is doubtful whether any development of the Seven Sisters falls will be feasible until the flow of the river can be regulated to at least 20,000 second-feet, by means of storage in the upper waters. The power available at the 34-foot site, under unregulated conditions, is about 11,600 horse-power and, under regulated conditions, 34,800 horse-power. Similarly, the 37-foot site will render available 12,600 horse-power and 30,700 horse-power respectively.

(c) McArthur Site.

At the lower of the two McArthur falls, a head of 18 feet awaits development. The river is here divided into two channels by a large island. The general layout consists of a solid concrete spillway along the crest of the fall on the right or main channel, and a long spillway and embankment, including sluiceway provision, running diagonally across the island, and connecting with the power station spanning the left channel. Provision is made on the island for the future construction of a lock.

The head-water elevation is at present fixed at 827, *i.e.*, about the highest recorded water level of Lac du Bonnet. The tail-water is proposed at 809, giving a head of 18 feet.

The initial installation provides for eleven 2,500 horse-power turbines, sufficient to provide for 12,000 second-feet at 8/10 gate, with a spare machine for emergency. On a 75 per cent efficiency, 24-hour basis, 18,400 horse-power will be available at a capital cost of $123 per horse-power at the low tension switchboard. The final installation provides for seventeen 2,500 horse-power units on a basis of a 20,000 second-feet flow and 75 per cent efficiency, 24-hour power, *i.e.*, of 30,700 horse-power. The cost per horse-power on the switchboard is $97.50. This site can be given a much more favourable aspect, when the local storage available in Lac du Bonnet (whose 32 square miles form the head-waters) is taken into consideration.

(d) Du Bonnet Site.

The proposed scheme of development at the Du Bonnet falls will ultimately concentrate there a head of 56 feet, made up of the Grand and Little du Bonnet falls, and the Whitemud falls. The latter will be added by blasting out the rock bridge over which the present fall takes place. The dam, consisting of embankment, spillway and sluiceway sections, leaves the left bank and crosses the river on the brink of the Little du Bonnet falls, connecting with the power station which parallels the right shore line below the pitch. Ice sluices and embankment connect the power station with the high land on the right bank. Provision is made for future lockage facilities on this bank.

The head-water elevation has been fixed at 808, with the tail-water at 762 previous to the blasting out of the Whitemud falls, and 752 subsequent thereto. This secures a head of 46 feet for the preliminary, and 56 feet for the final installation.

The initial installation is figured on seven 10,000 horse-power turbine units, utilizing 12,000 second-feet at 8/10 gate and 46-foot head. This on the same basis as set out above, will render available 47,100 horse-power at a capital cost of $79.40 per horse-power at the low tension switchboard. An intermediate installation, comprising 12 units and providing capacity for 20,000 second-feet at 46-foot head, and producing 78,700 horse-power has also been estimated. The cost of the power at the switchboard for this intermediate installation is $68.90 per horse-power. The final installation consists of

fourteen 10,000 horse-power units, for the development of 20,000 second feet at 56-foot head, the extra 10 feet being secured by the removal of the Whitemud falls. On the same basis as set out above, 95,500 24-hour horse-power will be available at a cost of $70.70 per horse-power on the switchboard.

(c) *Pine Falls Site.*

The Pine falls development will concentrate the natural drop of the Pine and Silver falls, giving a head of 37 feet. The dam runs diagonally across the river from the right bank, and joins directly to the power station, which forms a continuation of the dam. The power station is connected with the high ground on the left bank, by sluices and embankment. Provision is made for lockage facilities on this bank.

The head and tail-water elevations have been placed at 750 and 713 respectively. As the tail-water is practically lake Winnipeg level, it will vary from year to year with the level of the lake. The installation in the power station has not been finally determined, but the following estimates of the capital cost of the power are considered to be fairly close. The initial installation will provide for the development of 12,000 second-feet at 37-foot head, *i.e.*, 37,900 horse-power on the 75 per cent efficiency, 24-hour basis, at a cost of $80.30 per horse-power on the switchboard. The final installation provides for 20,000 second-feet, and renders available, on the above basis, 63,100 horse-power at a cost of $70.70 per horse-power on the switchboard.

8.—Summary of the Power Possibilities of the Winnipeg River.

Plate No. 8 is a tabulation of the powers, developed and undeveloped, of the Winnipeg river, under regulated and unregulated conditions. The undeveloped power is considered on a 75 per cent efficiency, 24-hour basis, and the capital cost per horse-power is given in terms of this power, estimated to the low tension switchboard in the power house.

Attention is called to the circular diagrams on plates No. 9 and No. 10 as illustrating, in a graphical manner, the developed and undeveloped power conditions along the river, under unregulated and regulated river flow.

PLATE No. 8.

Table of Developed and Undeveloped Power on the Winnipeg River.

Plant or Site.	Head-water Elevation.	Tail-water Elevation	Head.	Turbine Capacity at Full Gate at Govt. Proposals. 12000 sec.-ft.	Turbine Capacity at Full Gate at Govt. Proposals. 20000 sec.-ft.	H.P. at 75% Eff. on a 24 Hr. Basis. 12000 sec.-ft.	H.P. at 75% Eff. on a 24 Hr. Basis. 20000 sec.-ft.	H.P. Developed.	Capital Cost per H.P. on Switchboard. 12000 sec.-ft.	Capital Cost per H.P. on Switchboard. 20000 sec.-ft.	Remarks.
									$ cts.	$ cts.	
Winnipeg Municipal Plant	975·7	939·7	45	......	......	46,100	76,800	20,800	......	......	
Slave Falls Site	928	902	26	40,000	65,000	26,600	44,400	......	93.45	83.30	
Winnipeg Electric Railway Co. Plant	879·4	840·4	39	......	......	......	......	28,200	......	......	
First Site, Seven Sisters	......	......	34	......	......	11,600	34,800	......	......	......	Located on Pinawa channel.
Second Site, Seven Sisters	......	......	37	......	......	12,600	37,900	......	......	......	Less discharge down Pinawa channel.
McArthur Site	827	809	18	27,500	42,500	18,400	30,700	......	123.00	97.50	" " "
Du Bonnet Site	......	762	46	70,000	120,000	47,100	78,700	......	79.40	68.90	Preliminary head.
	808	752	56	......	140,000	57,300	95,500	......	......	70.70	Final head.
Pine Site	750	713	37	55,000	95,000	37,900	63,100	......	80.30	70.70	

Total power with unregulated river (12,000 second-feet min. flow)--238,700 horse-power.
Total power with regulated river (20,000 second feet reg. flow)--411,400 horse-power.
Total power developed to date 49,000 horse-power.

Ottawa, Ont., Dec. 12, 1913.

9.—Future Economic Value of the Winnipeg River Powers.

With regard to the future economic value of the powers of the Winnipeg river, one could not do better than quote from a report made to the Department of the Interior in September, 1911, by Mr. J. R. Freeman, one of the consulting engineers retained by the department for advice in connection with water-power matters. Mr. Freeman says:—

'*Economy and Conservation.*—While water-power opportunities on the Winnipeg river may have a very few years ago appeared so far beyond possible use that ordinary economics were unnecessary, it is, I believe, plain to-day beyond serious question that all of the remaining opportunities for power should be carefully conserved and only developed under such conditions as will not necessitate any great waste or the impairment of remaining opportunities.

'Sundry remarkable electro-chemical processes have been very recently invented, which promise to be of great future benefit to agriculture and other arts. Fertilizer for farmers' use is now being successfully made by electricity from the nitrogen of the air, and great water-powers in Norway are now being developed for these purposes in addition to those already in use, and recent developments have also been made of similar processes not far from the southern boundary of Canada.

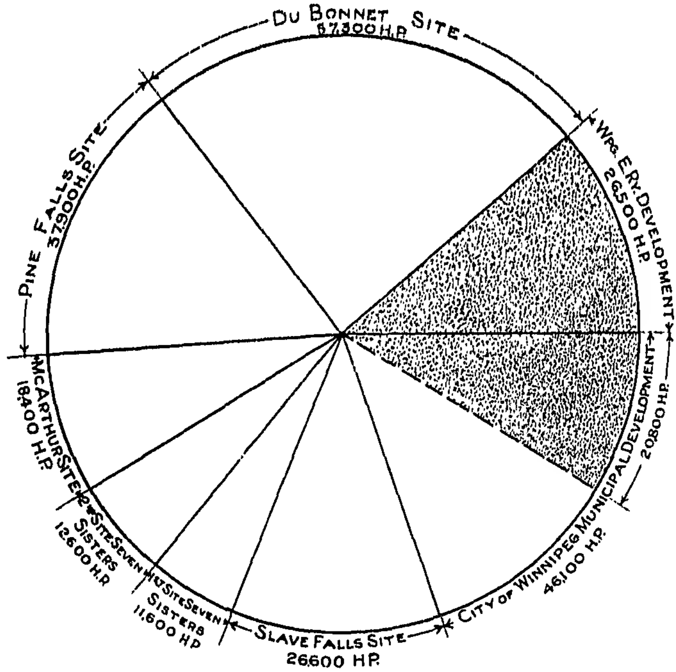
'The great uses of hydro-electric power at Niagara falls and at the Sault, for making aluminum, carbide for gas lighting, bleaching powders, and caustic soda and sundry other important products, were unknown only a few years ago. Indeed, it may be said that every one of the electro-chemical processes now located at Niagara falls has been invented since the first of the large hydro-electric power stations was built at that point. It is idle to say that the era of important electro-chemical invention is yet more than begun and, with the many able investigators now earnestly working on these lines in many parts of the world, great additional discoveries and commercial developments in the application of cheap electric power are almost sure to come, particularly in metallurgy, or the reduction of ores.

'*The Winnipeg Market now Fully Supplied.*—The city of Winnipeg will soon have all the power that it needs for public service corporation and for any conceivable manufacturing purposes likely to locate in or near the city for perhaps a score of years to come, from the railway company's plant already in use and to-day understood to be delivering about 22,000 horse-power and from the new municipal hydro-electric power plant at Pointe du Bois, now nearing completion, with a first installation of 26,000 horse-power, and with works planned to be extended to more than three times that capacity.

'Thus these two plants will be capable of delivering to Winnipeg more than 100,000 horse-power of 24-hour electrical energy, a quantity which can be best appreciated by a statement that it is far greater than the total water-power at Lowell, Lawrence, Manchester and Holyoke combined.

'*A possible Field for Use.*—The best use that I can foresee for the vast water-powers now remaining untouched upon the Winnipeg river is as the basis for founding three or four new industrial cities based upon electro-chemical industry, very much as water-power was the basis for creating, years ago, the cities of Lowell, Lawrence, Manchester, Holyoke, Bellowa Falls, and as, in recent years, it has brought together hundreds of new homes at Niagara Falls, Shawinigan Falls and at the Sault.

'We cannot to-day say what the line of manufacture may be, for the electro-chemical arts are still in a state of ferment and creation. It has



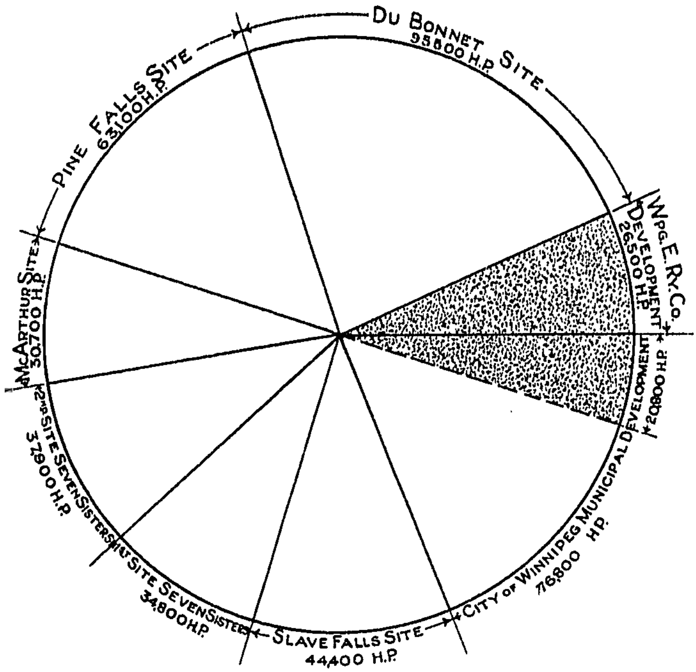
LEGEND: DEVELOPED POWER.
UNDEVELOPED POWER.

TOTAL POWER CAPACITY OF WINNIPEG RIVER WITHOUT REGULATED FLOW.... 237,000 H.P.
AMOUNT DEVELOPED TO DATE...47,300 H.P.

DIAGRAM
SHOWING
THE DEVELOPED AND UNDEVELOPED POWERS
AT THE VARIOUS SITES
ON THE
WINNIPEG RIVER

NOTE: Based on the unregulated flow of 12,000 Sec. Ft with undeveloped sites considered at 75% eff. with 24 hr. power.

Dec. 11th 1913.



LEGEND: DEVELOPED POWER ....
UNDEVELOPED POWER ......

TOTAL POWER CAPACITY OF WINNIPEG RIVER WITH REGULATED FLOW.....409,700 H.P.
AMOUNT DEVELOPED TO DATE..47,300 H.P.

DIAGRAM
SHOWING
THE DEVELOPED AND UNDEVELOPED POWERS
AT THE VARIOUS SITES
ON THE
WINNIPEG RIVER

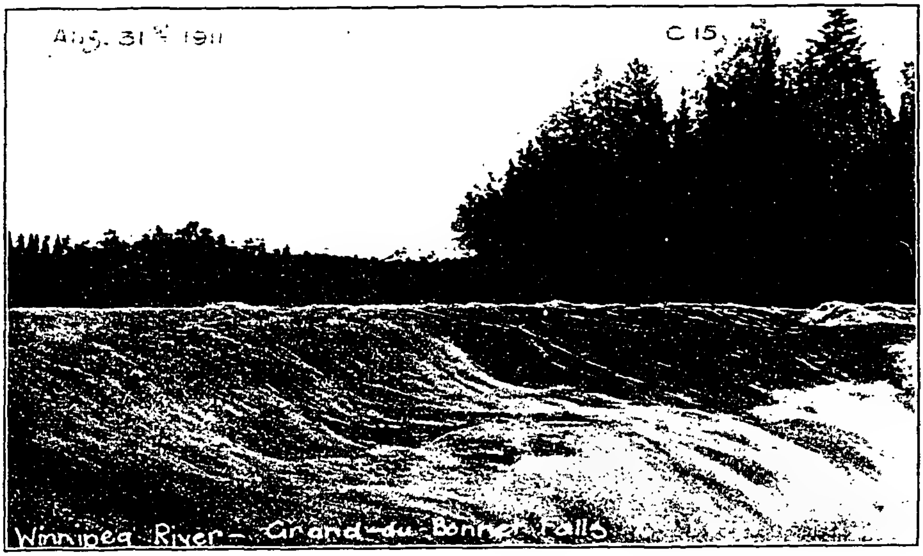
NOTE: Based on a regulated flow of 20,000 Sec. Ft. with undeveloped sites considered at 75% eff. with 24 hr. power.

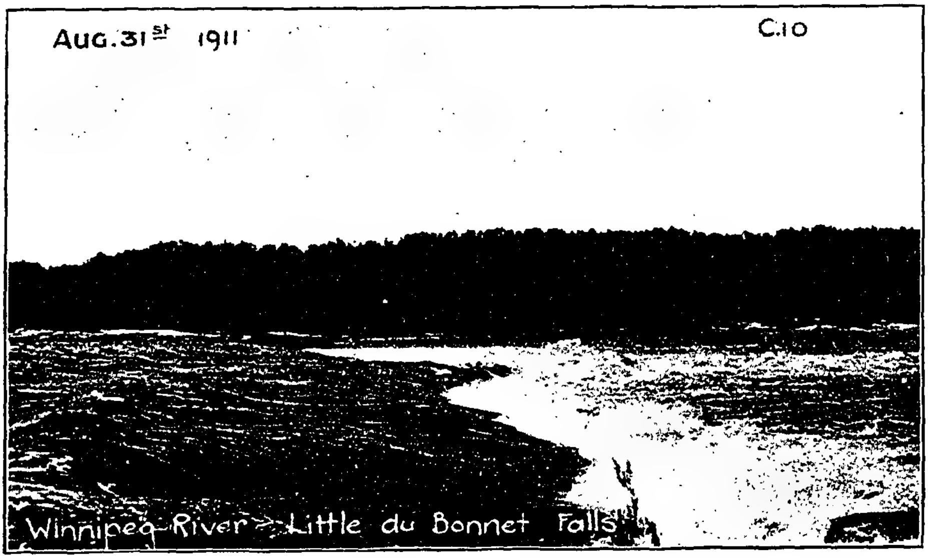
Dec 11th 1913.

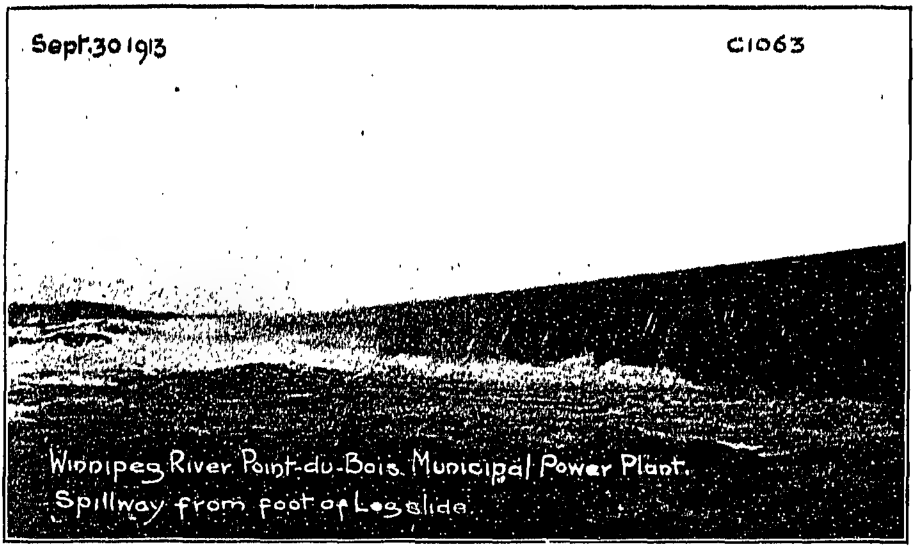
already been demonstrated that by electric smelting, steel for the manufacture of tools can be made having a quality and value difficult to obtain otherwise. Fertilizer, in the form of artificial saltpetre, is being produced commercially in large quantities under German processes, while carbide, carborundum, aluminum and numerous other useful products are being made by electro-chemical means in great quantity at Niagara and elsewhere, and sooner or later the time will come when fertilizers will not be scorned by the farmers of the Canadian Northwest. There is promise of new metallurgical processes for which electricity is a necessity, and the price per pound of several of these products is such that they could stand a considerable cost of freighting to their markets, and such that a power capable of being developed in so vast quantity at one point and at so low a cost per horse-power as appears practicable at three of the sites along the Winnipeg river, will surely be very attractive.'

'*These New Industries must Locate Close to the Water Fall.*—These electro-chemical processes, when carried on in the large commercial way, demand that the work be done close to the point where the power is generated, for two reasons: First, because although the air-saltpetre process uses alternating current, most electro-chemical processes require the direct current at low voltage which cannot be transmitted to great distances with anything like the facility of alternating current; and second, because, in order to attract these processes, it is necessary that the cost per horse-power be the very lowest and not overloaded by the cost of long transmission lines or the percentage of power necessarily lost in such transmission.

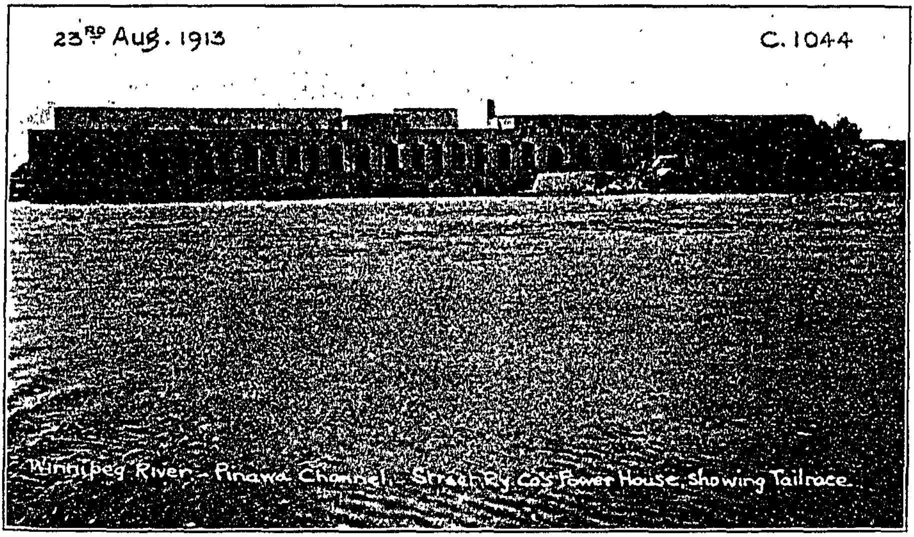
'Wherever a new industrial centre, with some hundreds of homes, can be established in the wilderness within a hundred miles of Winnipeg, it will add to Winnipeg's prosperity in a degree but little less than if located within its borders, and will add to the prosperity of the province by the new opportunities that it brings for employment, the diversity that it adds to its business interests and by the money that it will put into circulation. It is plain that many of the recent power developments made in various parts of America, from which the power is transmitted long distances to displace steam power in populous centres, results in putting a much larger number of men out of work than it sets at work. Such a development is of less benefit to the country than the early water-power developments which are used locally in creating the cities already named, in building hundreds of new homes and in setting thousands of men working at new opportunities.'


Aug. 31st 1911
C 15
Winnipeg River – Grand-du-Bonnet Falls

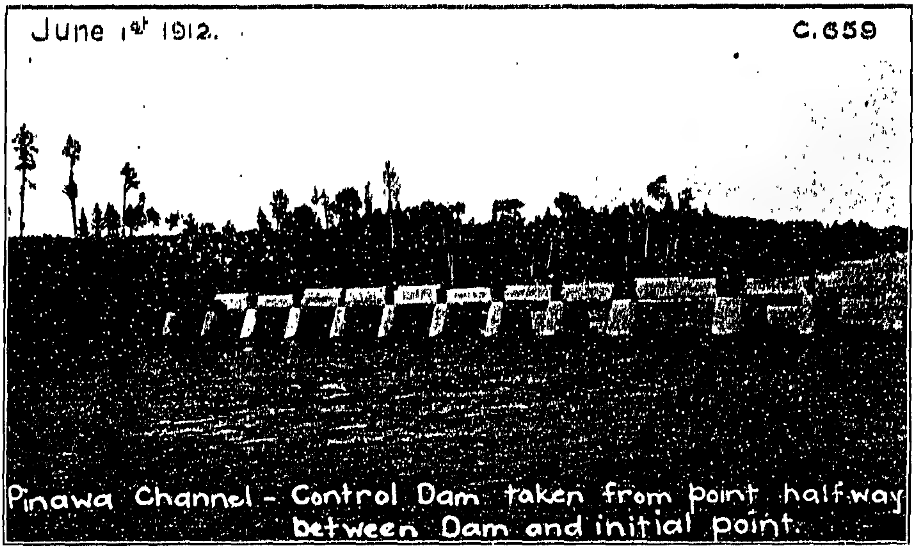

Aug. 31st 1911
C.10
Winnipeg River – Little du Bonnet Falls



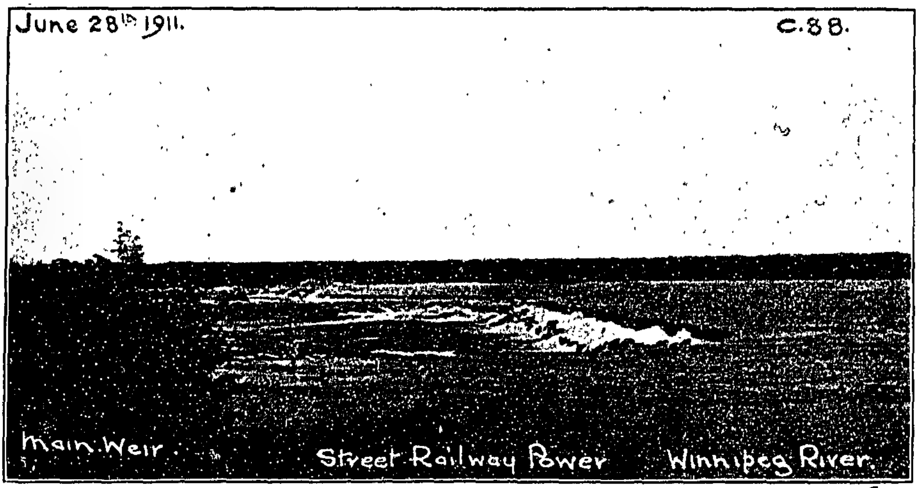
Winnipeg River. Point-du-Bois. Municipal Power Plant.
Spillway from foot of Logslide.



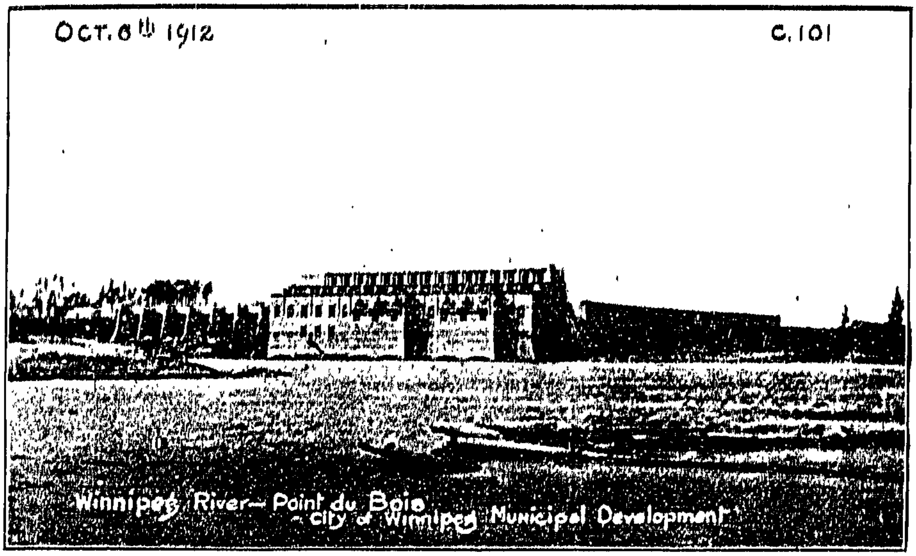
Winnipeg River – Pinawa Channel. – Street Ry. Co's Power House, showing Tailrace.

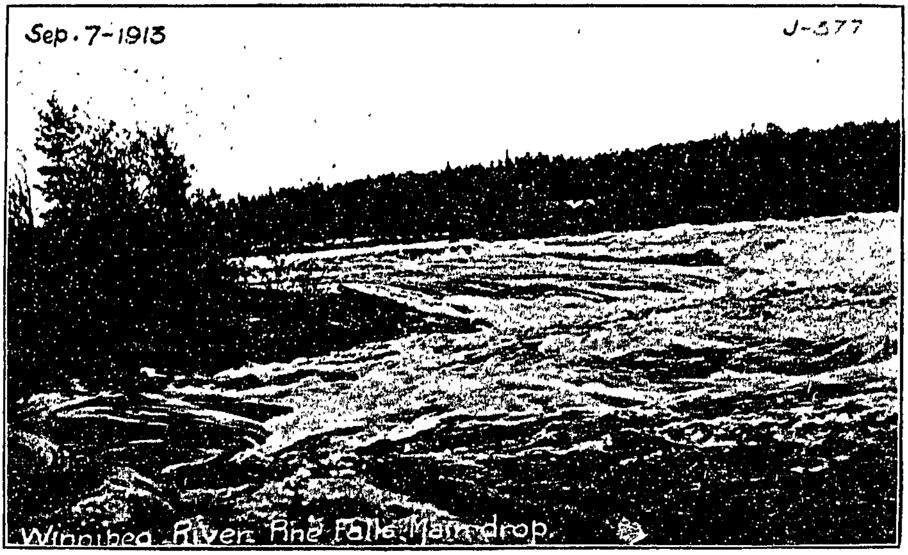


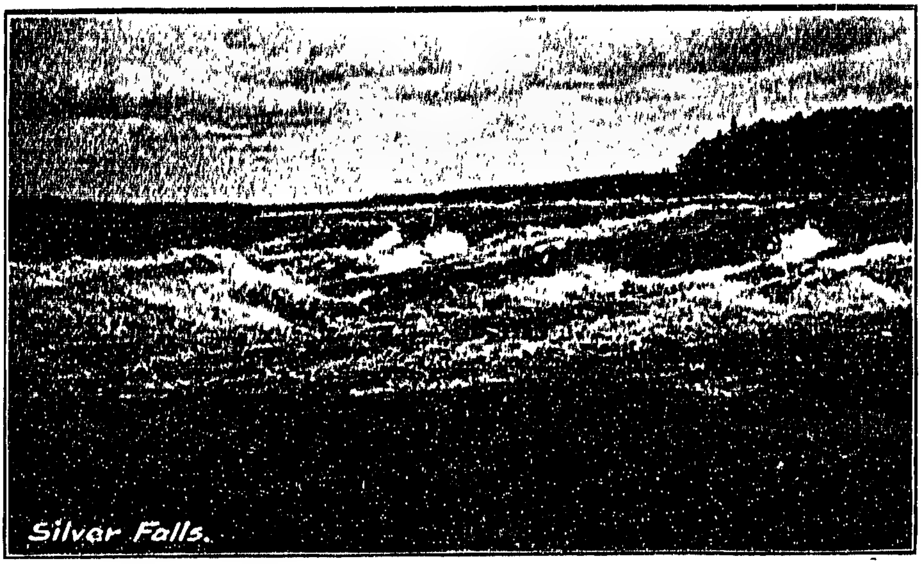
Pinawa Channel - Control Dam taken from point halfway between Dam and initial point.



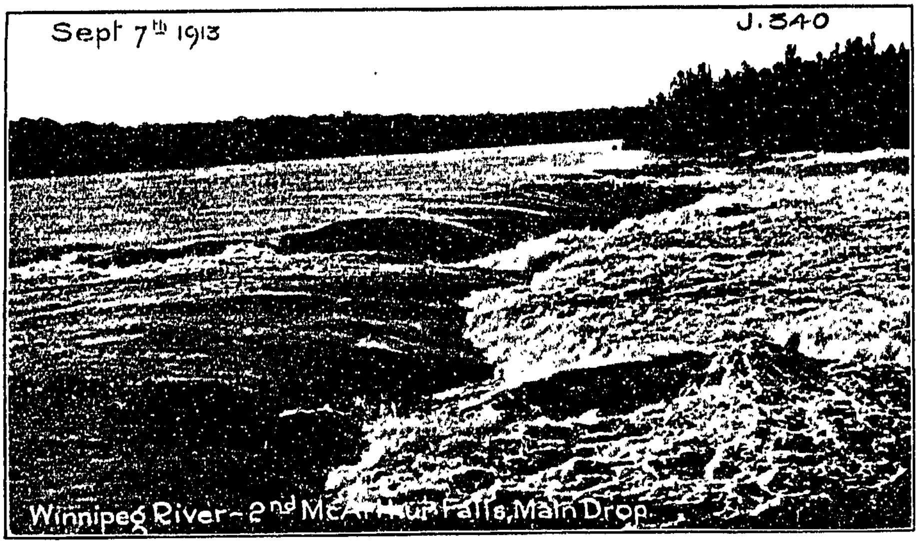
Main Weir. Street Railway Power Winnipeg River.


Oct. 6th 1912
C.101
Winnipeg River — Point du Bois
— City of Winnipeg Municipal Development


Sep. 7-1913
Winnipeg River Pine Falls Main drop

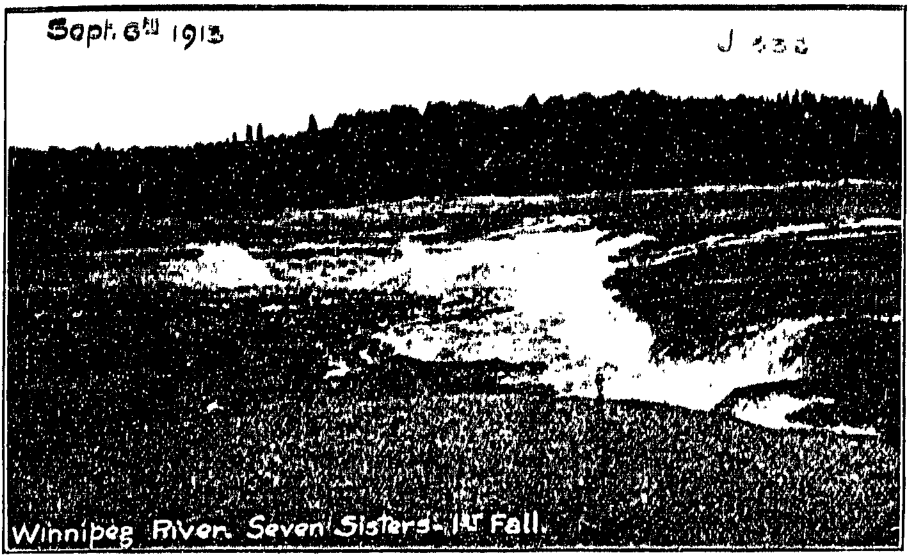


Silver Falls.



Sept 7th 1913 J.340

Winnipeg River – 2nd McArthur Falls, Main Drop.



Sept. 6th 1913
Winnipeg River. Seven Sisters - 1st Fall.

Sept. 6th 1913
Winnipeg River. Seven Sisters - 2nd Fall.

WATER-POWERS OF MANITOBA

CHAPTER IV

RIVERS IN SOUTHERN PORTION OF MANITOBA

CHAPTER IV.

RIVERS IN SOUTHERN PORTION OF MANITOBA.

WHITEMOUTH RIVER.

A.—LOCATION.

The Whitemouth river, see plate No. 11, has its source in Whitemouth lake, which is located in the southeasterly part of the province of Manitoba. The general direction of the river is northeasterly from its source to the point where it joins the Winnipeg river, just below the Seven Sisters rapids.

B.—RIVER BASIN.

The drainage area of the river is 1,566 square miles. The lower section of this area is narrow and mostly broken up in farm lands, while the upper section spreads out and is part of what is known as the Julius muskeg.

C.—BED AND BANKS.

The bed of the river consists almost entirely of boulder clay, with occasional outcrops of rock in the lower reaches, crossing the river at right angles. These rock outcrops do not appear above bed elevation except in the vicinity of Whitemouth falls at the mouth of the river. The banks throughout, with the above exception, are composed of a sandy clay, and rise to a height of approximately 50 feet. In some localities this height is reached by a quick slope from the water's edge, while in others the slope is more gradual, running back for a distance of 400 feet.

D.—TIMBER AND VEGETATION.

For a distance of about two miles from the mouth of the river there is a large amount of valuable standing timber, including oak, spruce and poplar, but as its course is followed southward it is found that the land has been cleared off, partly by fire and partly by the efforts of the settlers in breaking up the land for farming purposes, so that only occasional clumps of poplar, ash and elm are encountered. Throughout the upper reaches of the river the land is mostly covered with small tamarack, spruce and scrub.

E.—RUN-OFF.

(*a*) *Rainfall.*—From the meteorological reports at Oakbank, to the west of the drainage basin, and at Kenora to the east, extending over a period of 22 and 9 years, respectively, it is found that the mean annual precipitation for the section of the country covered by the drainage area is approximately 21 inches.

(*b*) *Discharge Measurements.*—A metering station was established on the river at the town of Whitemouth, by the Manitoba Hydrographic Survey, in May of the year 1912. During the years of 1912-13, there have been twelve discharge measurements made at this station, the results of which are shown in table No. 25.

Daily gauge height records have also been kept at this point, and these, with their assumed daily discharges, are tabulated in tables No. 26 and No. 27.

F.—POWER SURVEY.

A reconnaissance survey of the river from the mouth up to the C.P.R. crossing at the town of Whitemouth was made by the Manitoba Hydrographic Survey in June of the present year.

G.—POWER POSSIBILITIES.

The reconnaissance profile on plate No. 11A of the power survey, shows the difference in elevation from the mouth of the river to the town of Whitemouth to be 44 feet, or 2·6 feet per mile.

Site No. 1.—Part of this drop could be concentrated at the falls at the mouth of the river, and a head of 20 feet obtained.

Site No. 2.—About three miles below the town of Whitemouth a head of approximately 20 feet is obtainable, the high banks lending themselves to successful development without flooding any considerable area of valuable land.

H.—WATER-POWER.

Based on the estimates of flow for the year ending October 31, 1913, the following table gives the power available per foot head at an 80 per cent efficiency, and is computed on a low flow of 25 second-feet, and also for the lowest monthly mean flow (100 second-feet) for a period of six months from May to October. In this latter case the estimated power only relates to the period as above stated:—

Head in Feet.	Estimated Horse-power at 80 per cent Efficiency.	
	Minimum flow 25 sec.-ft.	Flow 100 sec.-ft. Period May to October.
1	2·3	9·0
10	23	90
20	46	180

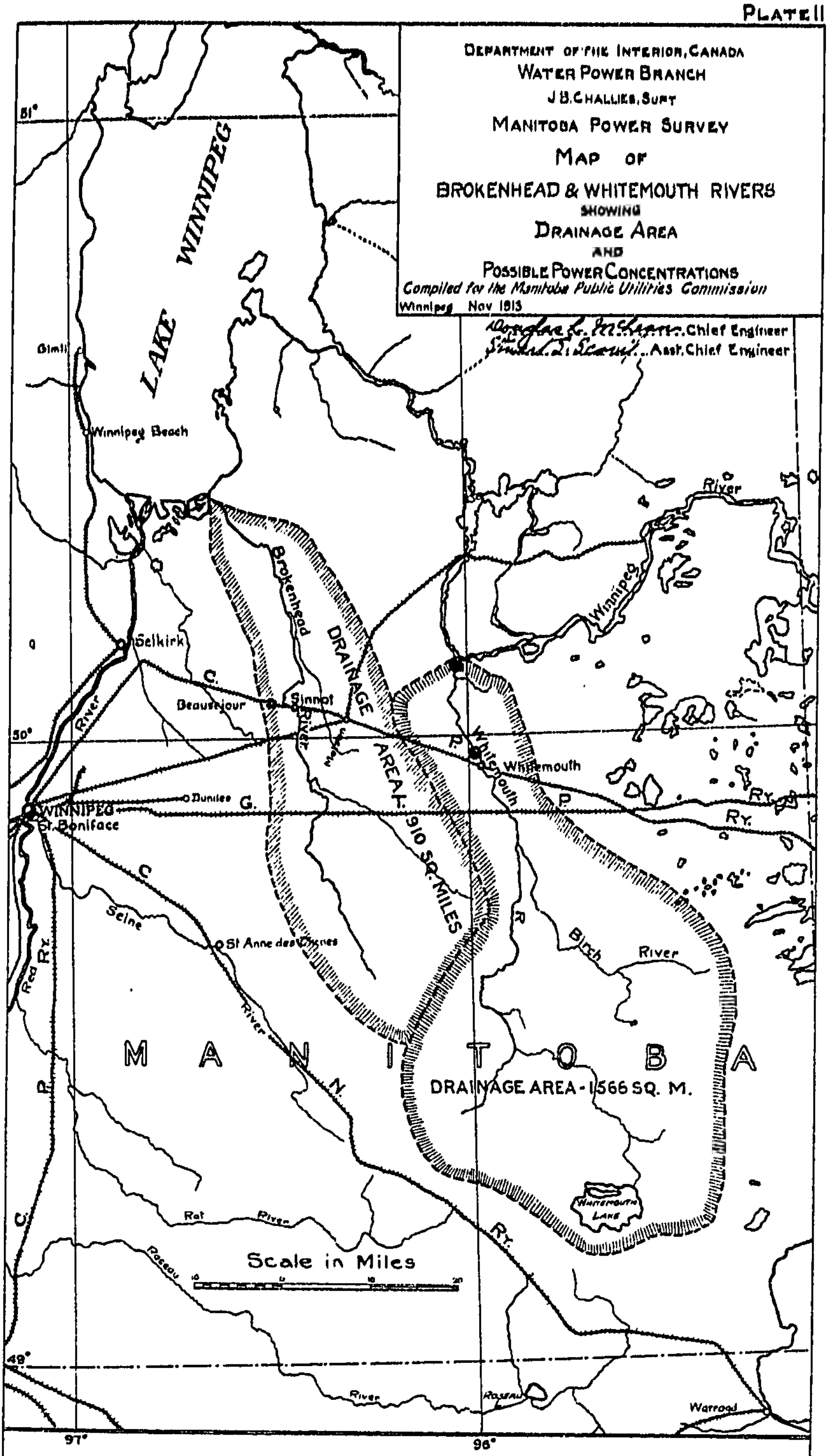
TABLE No. 25.

Discharge Measurements of Whitemouth River at Whitemouth, 1912–13.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
1912.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-Ft.
May 29	G. H. Burnham	1187	162	990·5	2·20	4·86	2,179
June 20	"	1187	151	629·4	1·07	2·48	673
July 13	"	1187	158	749·9	1·41	3·08	1,057
July 15	"	1187	158·5	858·4	1·67	3·70	1,433
Aug. 9	W. G. Worden	1187	149·7	699·6	1·30	2·95	910
Sept. 3	"	1187	149·7	835·0	1·59	3·72	1,328
Oct. 15	R. H. Nelson	1187	172·0	936·8	2·02	4·48	1,892
1913.							
Jan. 24	A. Pirie	1469	110·0	188·6	0·145	1·22	*27
Apr. 18	"	1186	154·0	752·0	1·65	3·29	1,241
May 9	G. Ebner	1186	151·0	732·1	1·38	2·92	1,010
Aug. 15	W. J. Ireland	1469	143·0	578·0	0·68	1·95	392
Sept. 21	C. O. Allen	1435	136·0	512·2	0·30	1·44	153

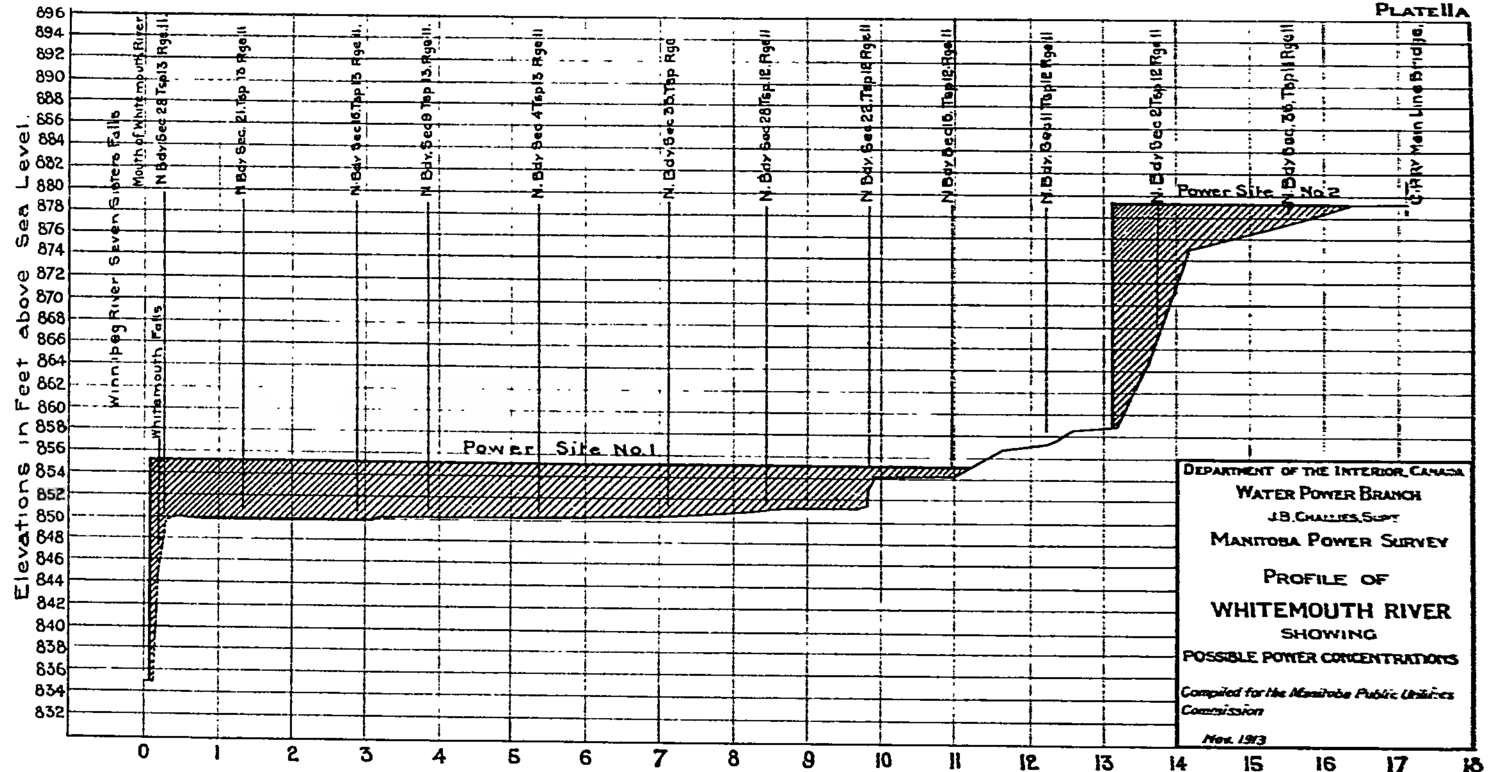
* Ice-measurement.

PLATE II



DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT
MANITOBA POWER SURVEY
MAP OF
BROKENHEAD & WHITEMOUTH RIVERS
SHOWING
DRAINAGE AREA
AND
POSSIBLE POWER CONCENTRATIONS
Compiled for the Manitoba Public Utilities Commission
Winnipeg Nov 1913
Chief Engineer
Asst. Chief Engineer
LAKE WINNIPEG
Gimli
Winnipeg Beach
Selkirk
Beausejour
Sinnot
Whitemouth
Winnipeg
WINNIPEG
St. Boniface
Dunlea
St Anne des Chenes
Brokenhead
River
DRAINAGE AREA 910 SQ. MILES
DRAINAGE AREA - 1566 SQ. M.
Whitemouth R
Birch River
Seine
Rat River
Roseau River
Red River
Warroad
WHITEMOUTH LAKE
M A N I T O B A
Scale in Miles
51°
50°
49°
97°
96°

PLATE IIA



DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT.
MANITOBA POWER SURVEY

PROFILE OF
WHITEMOUTH RIVER
SHOWING
POSSIBLE POWER CONCENTRATIONS

Compiled for the Manitoba Public Utilities Commission

Nov. 1913

Douglas L. McLean Chief Engineer
Stuart B. Stewart Asst. Chief Engineer

TABLE No. 26.

Daily Gauge Height and Discharge, Whitemouth River at Traffic Bridge, Whitemouth, for 1912.

Day.	May.		June.		July.		August.		September.		October.		November.		December.	
	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	......	......	4·37	1829	1·76	347	3·30	1130	3·67	1356	4·77	2109	3·20	1505	......	......
2	......	......	4·05	1605	1·66	304	3·04	982	3·71	1382	4·68	2046	3·94	1531	......	......
3	......	......	3·92	1518	1·54	256	2·93	922	3·70	1375	4·52	1934	4·00	1570	......	......
4	......	......	4·10	1640	1·51	241	2·61	746	3·75	1408	4·49	1913	3·91	1512	......	......
5	......	......	4·15	1675	1·50	240	2·60	740	4·23	1731	4·11	1857	3·84	1466	......	......
6	......	......	4·05	1605	1·90	410	2·58	730	4·11	1647	4·38	1836	3·75	1468	......	......
7	......	......	3·82	1453	1·95	483	2·62	751	4·02	1584	4·32	1794	3·62	1323	......	......
8	......	......	3·76	1114	2·31	610	2·73	812	3·91	1512	4·55	1955	3·51	1256	......	......
9	......	......	3·64	1336	2·55	715	2·92	916	3·87	1486	4·80	2130	3·42	1202	......	......
10	......	......	3·24	1094	2·60	740	2·92	916	3·92	1518	4·80	2130	3·36	1166	......	......
11	......	......	3·23	1088	2·64	762	2·91	911	3·97	1551	4·79	2123	3·31	1136	......	......
12	......	......	3·04	982	2·63	757	2·91	911	3·99	1564	4·75	2095	3·28	1118	......	......
13	......	......	3·02	971	3·14	1037	2·72	806	3·98	1557	4·71	2067	3·22	1082	......	......
14	......	......	2·98	949	3·46	1226	2·65	768	3·96	1544	4·60	1990	3·19	1065	......	......
15	......	......	2·82	861	3·72	1388	2·57	725	3·93	1525	4·47	1899	3·16	1048	......	......
16	......	......	2·78	839	3·77	1421	2·52	700	4·18	1696	4·19	1703	3·12	1026	......	......
17	......	......	2·56	720	3·77	1421	2·38	630	4·30	1780	4·10	1640	3·12	1026	1·74	......
18	......	......	2·54	710	3·76	1414	2·32	600	4·25	1745	3·92	1518	3·06	993	......	......
19	......	......	2·51	695	3·76	1411	2·28	581	4·18	1696	3·91	1512	3·02	971	......	......
20	......	......	2·50	690	3·46	1226	2·06	482	3·95	1538	3·88	1492	3·00	960	......	......
21	......	......	2·36	620	3·38	1178	2·04	473	4·53	1911	3·72	1388	2·91	911	......	......
22	......	......	2·20	545	3·28	1118	2·12	509	4·98	2256	3·64	1336	2·86	883	......	......
23	......	......	2·18	536	3·39	1184	2·22	554	5·08	2326	3·52	1262	2·78	839	......	......
24	......	......	2·16	527	3·58	1298	2·35	615	5·14	2375	3·42	1202	2·91	......	......	......
25	......	......	2·16	527	3·73	1395	2·41	645	5·12	2361	3·21	1076	3·16	......	......	......
26	......	......	2·15	523	3·80	1140	2·41	660	5·08	2326	3·06	993	3·32	......	......	......
27	......	......	2·13	514	3·84	1466	2·46	670	5·00	2270	3·48	1238	3·38	......	......	......
28	......	......	2·11	505	3·92	1518	2·50	690	4·99	2263	3·66	1319	3·42	......	......	......
29	4·82	2144	2·00	455	3·81	1447	2·52	700	4·90	2200	3·76	1414	3·42	......	......	......
30	4·83	2151	1·86	392	3·67	1356	2·92	916	4·85	2165	3·82	1153	3·42	......	......	......
31	4·56	1962	......	......	3·48	1238	3·52	1262	......	......	3·81	1466	......	......	......	......

TABLE

Daily Gauge Height and Discharge, Whitemouth

Day.	January.		February.		March.		April.		May.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	...	...	1·34	...	1·12	...	...	...	3·33	1279
2	...	...	...	...	...	...	...	...	3·29	1254
3	...	...	...	...	...	...	...	...	3·21	1202
4	...	...	...	...	...	...	...	...	3·15	1164
5	...	...	...	...	...	...	...	...	3·12	1145
6	...	...	...	...	...	...	...	...	3·09	1126
7	...	...	...	...	...	...	...	...	3·00	1068
8	...	...	...	...	1·14	...	5·11	2418	3·00	1068
9	...	...	...	...	...	...	5·32	2553	2·92	1017
10	...	...	...	...	...	...	5·42	2617	2·92	1017
11	...	...	...	...	...	...	5·82	2873	2·96	1042
12	...	...	...	...	1·14	...	6·25	3148	2·94	1030
13	...	...	1·16	...	...	...	5·48	2655	2·91	1010
14	...	...	...	...	...	...	4·96	2322	2·88	991
15	...	...	...	...	...	...	4·88	2271	2·80	940
16	...	...	...	...	...	...	4·82	2233	2·70	876
17	...	...	...	...	...	...	4·76	2194	2·62	825
18	...	...	...	...	...	...	3·29	1254	2·62	825
19	...	...	...	...	...	...	3·25	1228	2·58	799
20	...	...	...	...	...	...	3·25	1228	2·52	761
21	...	...	...	...	...	...	3·22	1209	2·49	742
22	...	...	1·14	...	1·14	...	3·21	1202	2·45	716
23	...	...	...	...	...	...	3·46	1362	2·45	716
24	...	...	...	...	...	...	3·59	1446	2·43	703
25	1·34	...	...	...	...	...	3·66	1490	2·41	690
26	...	...	...	...	...	...	3·72	1529	2·39	678
27	...	...	...	...	...	...	3·72	1529	2·35	652
28	...	...	...	...	...	...	3·70	1516	2·35	652
29	...	...			...	...	3·62	1465	2·33	639
30	...	...			...	...	3·50	1388	2·30	620
31	...	...			...	...	...	...	2·28	607

No. 27.

River at Traffic Bridge, Whitemouth, for 1913.

Days.	June. Gauge Height.	June. Discharge.	July. Gauge Height.	July. Discharge.	August. Gauge Height	August. Discharge.	September. Gauge Height.	September. Discharge.	October. Gauge Height.	October. Discharge.
	Feet.	Sec.-ft.	Feet.	Sec. ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	2·30	620	2·36	658	1·46	160	2·08	479	1·38	138
2	2·27	601	2 53	767	1·42	149	2·03	147	1·34	128
3	2 25	588	2 51	754	1·36	133	1·95	396	1·26	110
4	2·25	588	2·48	735	1·34	128	1·93	383	1·24	106
5	2·25	588	2·36	658	1·28	114	1·88	351	1·28	114
6	2·33	639	2·28	607	1·28	114	1·83	319	1·33	126
7	2 61	818	2·19	550	1·22	102	1·76	288	1·31	121
8	2·52	761	2·06	466	1·18	94	1·71	255	1·29	116
9	2·43	703	2·06	466	1·14	87	1 63	221	1 38	
10	2 35	652	2·00	428	1·11	82	1·68	242	1·46	
11	2·23	575	2·08	479	1·08	77	1·79	295	1·58	
12	2·18	543	2 18	543	1·08	77	1·62	216	2·58	
13	2·21	562	2.76	914	1·04	72	1·60	208	2·75	
14	2 17	537	3·05	1100	1·62	216	1·55	190	3 01	
15	2·08	479	3·10	1132	1 84	326	1·48	166	3.06	
16	2·08	479	3·26	1284	2·23	575	1·46	160	3 09	
17	1·88	351	2·95	1035	2·62	825	1·38	138	3·03	
18	1·86	338	2 83	959	2 76	914	1·46	160	2 94	
19	1·74	270	2·61	818	2·71	882	1·58	201	2 97	
20	1·76	280	2·54	774	2 66	850	1·54	186	2 90	
21	1·68	242	2 36	658	2·63	831	1 51	176	2 88	Ice.
22	1·67	237	2·20	556	2·54	774	1·50	172	2·78	
23	1·60	208	2·20	556	2·48	735	1·48	166	2 77	
24	1·58	201	2·13	511	2 46	722	1·48	166	2·70	
25	1·52	179	2 08	479	2·38	671	1·46	160	2·66	
26	1 49	169	1·96	402	2·38	671	1·42	149	2·60	
27	1·45	158	1·82	313	2·29	614	1·43	152	2·51	
28	1·45	158	1·69	246	2·21	562	1·41	146	2·56	
29	1·67	237	1·68	242	2·18	543	1·38	138	2 53	
30	1·82	313	1·55	190	2·12	505	1·36	134	2·51	
31	....	....	1·54	186	2·14	518	....	....	2·36	

The Brokenhead River.

A.—LOCATION.

The Brokenhead river (see plate No. 11) flows into the southeasterly section of lake Winnipeg. It drains a long narrow strip of land lying between the watersheds of the Winnipeg and Whitemouth rivers on the east, and the Red river on the west.

B.—RIVER BASIN.

The drainage area of the river is 910 square miles, its greatest width being twenty-two miles and its length, from mouth to head-waters, seventy-five miles. The greater part of this area is low-lying and marshy land, though along the banks of the river a certain amount of reclamation work has been done in the lower reaches, and the land is broken up for farming purposes.

In the upper basin of the river much of the land is swampy and cannot be settled or cultivated until some system of drainage has been carried out.

C.—BED AND BANKS.

The bed and banks of the river are composed of sandy clay, intermixed in some sections with large boulders.

The banks, as a general rule, are low-lying, and rise above the bed of the stream from five to ten feet.

D.—RUN-OFF.

(*a*) *Rainfall.*—From rainfall records obtained, it is found that the mean annual precipitation in the drainage basin of the river is 22 inches.

(*b*) *Discharge Measurements.*—A metering station was established on the river at the village of Sinnot in May of the year 1912 by the Manitoba Hydrographic Survey, and since that time continuous observations as to flow have been made.

These observations include eleven meterings taken during the different stages of the river, the results of which are shown in table No. 28.

Daily gauge height records have also been kept at the metering station and these, with their estimated daily discharges, are shown in tables No. 29 and No. 30.

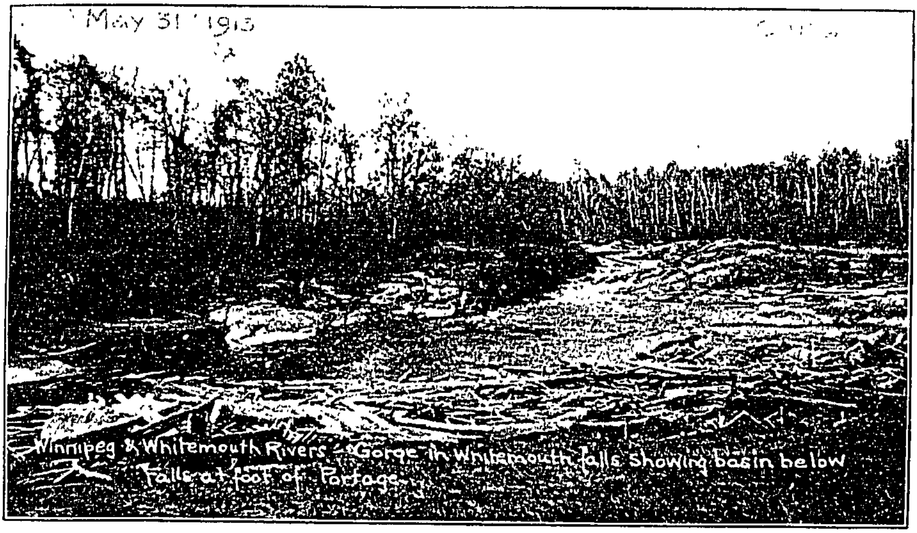
E.—POWER POSSIBILITIES.

There has been no survey work done on this river with the view to locating power sites, and it is doubtful, considering the nature of the country through which it flows, if there are any such on the river. If any should be located, the development of the same would necessarily be for operation only through the open season, as it has been found that flow is liable to be completely cut off during the winter months.

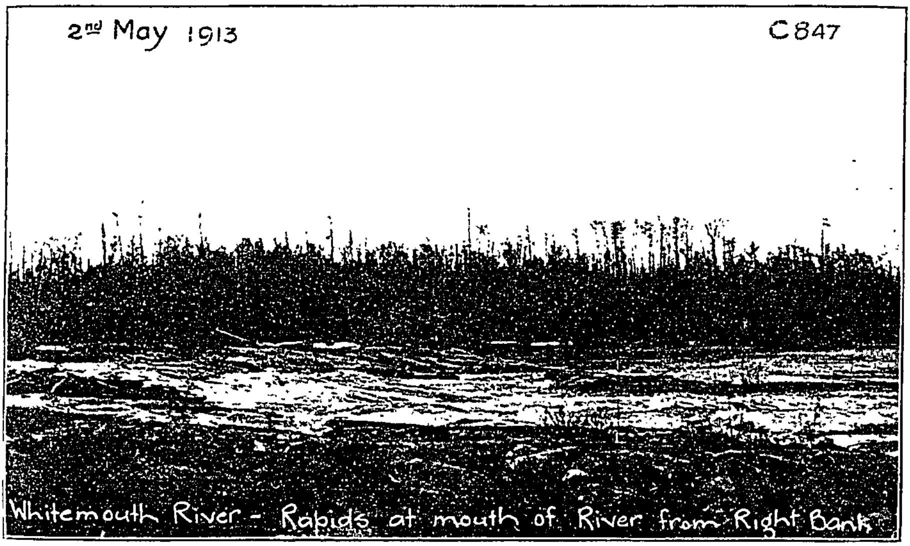
The fall in the river from the village of Sinnot to lake Winnipeg, a distance of approximately forty miles, is seventy-two feet, or 1·8 feet per mile.

F.—WATER-POWER.

During the year ending October 31, 1913, it will be seen from the discharge tables, that the flow was entirely cut off during the months of January, February and March, with the extremely low estimated flow of 10 second-feet in December. Taking into account these conditions, it is found necessary to base any computations as to avail-



Winnipeg & Whitemouth Rivers - Gorge in Whitemouth Falls showing basin below Falls at foot of Portage.



Whitemouth River - Rapids at mouth of River from Right Bank

able water-power on the stimates of flow for a partial year, as no continuous operation would have been possible on this river during the above period.

Based on the estimates of flow for the year ending October 31, 1913, the following table gives the power available per foot head at an 80 per cent efficiency, and is computed on the lowest monthly mean flow (89 second-feet), for the period of seven months from April to October. This estimated power only relates to the period as above stated:—

Head in Feet.	Estimated Horse-power at 80 per cent Efficiency.
	Flow 89 sec.-ft.-Period April to Oct.
1	8
10	80
20	160

TABLE No. 28.

Discharge Measurements of Brokenhead River at Sinnot, for 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Area of sections.	Mean velocity.	Gauge height.	Discharge.
1912.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
May 30	G. H. Burnham	1187	88	382	1·74	3·79	665
June 20	" "	1187	88	198	0·95	1·94	188
July 15	" "	1187	88	201	0·86	1·81	173
Aug. 9	W. G. Worden	1187	86	136	0·42	1·21	58
Sept. 3	" "	1187	87	166	0·52	1·54	86
Oct. 15	R. H. Nelson	1186	76	341	1·39	3·18	474
1913.							
Jan. 21	Alex. Pirie	......	......	......	......	......	0*
April 19	" "	1186	89	298	1·50	2·98	447
May 9	G. Ebner	1186	85	228	1·16	2·14	264
Aug. 15	W. J. Ireland	1469	82·5	224	0·98	2·23	219
Sept. 27	C. O. Allen	1435	80	155	0·56	1·40	87

* River frozen to bottom.

TABLE No. 29.

DAILY GAUGE HEIGHT AND DISCHARGE, Brokenhead River, near Sinnot, for 1912.

Date.	June.		July.		August.		September.		October.		November.		December.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	0·92	27	1·69	134	1·40	75	4·01	690	2·70	376		
2	....	....	0·85	24	1·59	110	1·47	87	3·95	676	2·79	398		
3	....	....	0·80	21	1·49	90	1·51	94	3·85	652	2·79	398	1·72	
4	....	....	0·74	18	1·41	77	1·91	186	3·72	621	2·70	376		
5	....	....	0·70	16	1·31	62	1·90	184	3·60	592	2·66	366		
6	....	....	0·71	17	1·31	62	1·84	170	3·55	580	2·60	352		
7	....	....	0·74	18	1·28	59	1·80	160	3·51	570	2·59	350		
8	3·52	573	0·83	23	1·23	53	1·83	167	3·50	568	2·60	352		
9	3·40	544	0·80	21	1·21	51	1·90	181	3·48	563	2·60	352		
10	3·23	503	0·91	27	1·21	51	1·85	172	3·43	551	2·68	371	0·90	
11	3·05	460	0·95	29	1·20	50	1·84	170	3·40	544	2·70	376		
12	2·88	419	2·60	352	1·19	49	1·83	167	3·39	542	2·68	371		
13	2·73	383	2·14	242	1·21	51	1·84	170	3·32	525	2·63	359		
14	2·60	352	1·75	148	1·20	50	2·52	333	3·29	518	2·60	352		
15	2·46	318	1·83	167	1·15	45	2·66	366	3·20	496	2·58	347		
16	2·32	285	1·72	141	1·11	41	2·84	410	3·15	484	2·54	338		
17	2·24	266	1·85	172	1·08	38	3·11	474	3·09	470	2·49	326	0·70	
18	2·14	242	1·74	146	1·05	36	2·99	446	3·00	448	2·45	316		
19	2·06	222	1·68	131	1·00	32	3·19	494	2·97	441	2·40	304		
20	1·98	203	1·63	119	0·98	31	3·28	515	2·90	424	2·38	299		
21	1·80	160	1·55	102	0·95	29	3·98	683	2·82	405	2·20	256		
22	1·79	158	1·52	96	0·90	26	4·00	688	2·71	378	2·08	227		
23	1·68	131	1·54	100	0·90	26	4·10	712	2·69	374	1·80	160		
24	1·59	110	1·75	148	1·00	32	4·27	753	2·64	362	1·90	184	0·60	
25	1·35	68	1·74	146	0·99	31	4·27	753	2·59	350	2·59	....		
26	1·39	74	1·70	136	1·01	33	4·29	758	2·54	338	2·60	....		
27	1·29	60	1·91	186	1·05	36	4·28	755	2·49	326	2·50	....		
28	1·20	50	2·01	210	1·12	42	4·20	736	2·45	316	2·49	....		
29	1·01	33	1·96	198	1·19	49	4·15	724	2·40	304	2·45	....		
30	1·00	32	1·84	170	1·98	203	4·10	712	2·40	304	2·40	....		
31	....	....	1·79	158	1·40	75	....	....	2·50	328	....	....	0·50	

TABLE No. 30.

Daily Gauge Height and Discharge, Brokenhead River, near Sinnot, for 1913.

Date.	April.		May.		June.		July.		August.		September.		October.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	2·65	364	1·50	92	2·95	436	0·69	16	2·49	326	1·25	56
2	....	....	2·58	347	1·53	98	3·00	448	0·67	14	2·46	318	1·20	50
3	....	....	2·53	335	1·50	92	2·98	443	0·60	12	2·35	292	1·18	48
4	....	....	2·49	326	1·48	89	2·80	400	0·59	12	2·26	270	1·15	45
5	....	....	2·41	306	1·45	83	2·68	371	0·57	11	2·01	208	1·10	40
6	....	....	2·40	304	1·70	136	2·45	316	0·56	11	1·90	184	1·08	38
7	....	....	2·30	280	1·84	170	2·30	280	0·53	10	1·90	184	1·10	40
8	....	....	2·23	268	....	157	2·20	256	0·50	9	1·80	160	1·20	50
9	....	....	2·16	246	....	143	1·90	184	0·48	8	1·79	158	1·35	68
10	....	....	2·10	232	....	129	1·78	155	0·60	12	1·84	170	1·46	85
11	....	....	2·08	227	....	116	1·95	196	0·59	12	2·00	208	1·65	124
12	....	....	2·08	227	....	102	1·94	194	0·54	10	2·04	218	1·80	169
13	....	....	2·07	225	....	88	2·00	208	0·50	9	2·09	230	1·90	184
14	....	....	2·07	225	....	74	2·10	232	0·49	9	2·05	220	2·00	208
15	....	....	2·03	215	1·30	61	1·97	201	1·54	100	2·00	208	2·00	208
16	....	....	2·00	208	1·24	54	1·90	184	2·50	328	1·96	195	1·95	196
17	....	....	1·96	198	1·20	50	1·88	179	2·65	364	1·90	184	1·90	184
18	....	....	1·94	194	1·10	40	1·84	170	2·70	376	1·83	167	1·88	179
19	1·50	....	1·89	182	1·06	37	1·70	136	2·75	388	1·70	136	1·80	160
20	....	....	1·84	170	0·90	26	1·55	102	2·70	376	1·60	112	1·78	155
21	....	....	1·80	160	0·80	21	1·46	85	2·60	352	1·60	112	1·74	146
22	....	....	1·75	148	1·00	32	1·40	75	2·54	338	1·58	108	1·70	136
23	....	....	1·74	146	0·94	28	1·30	61	2·53	335	1·53	98	1·64	122
24	....	....	1·70	136	0·86	24	1·28	59	2·53	335	1·50	92	1·60	112
25	....	....	1·68	131	0·80	21	1·18	48	2·52	333	1·45	83	1·58	108
26	....	....	1·65	124	0·79	20	1·09	39	2·51	330	1·42	80	1·58	108
27	....	....	1·60	112	0·70	16	1·00	32	2·50	328	1·40	75	1·57	106
28	....	....	1·59	110	0·90	26	0·90	26	2·49	326	1·36	69	1·56	104
29	2·80	400	1·56	104	2·18	251	0·80	21	2·48	323	1·33	65	1·56	104
30	2·72	381	1·53	98	2·80	400	0·75	19	2·50	328	1·30	61	1·55	102
31	....	....	1·50	92	....	....	0·70	16	2·50	328	....	....	1·54	100

The Roseau River.

A.—LOCATION.

The Roseau river is the largest tributary entering the Red river from the east, in its course through the province of Manitoba. It has its head-waters in the low lands lying to the west of the Lake of the Woods. About half of its total length lies south of the international boundary, and it joins the Red river approximately ten miles north of same.

The general direction of the river is northwest, and similar to the Red river its course is very winding throughout its length.

B.—RIVER BASIN.

The drainage basin of the river covers an area of 1987 square miles, 1097 of which are in the State of Minnesota, the balance, 890, being in Manitoba.

The greater part of this area is flat land, that in the upper reaches being such that it was impossible to cultivate the same without artificial drainage. In connection with this work, forty miles of the upper section of the river in Minnesota has been straightened and widened to eighty feet, and the land on either side for a considerable distance drained into same, with ditches spaced one mile apart.

The effect of this drainage is shown in the lower reaches of the river by the rapid rise apparent during times of heavy rainfall.

C.—BED AND BANKS.

The course of the river from its source to its mouth lies through level country, with no perceptible valley of any extent. The banks cut sharply down from the prairie level to the bed of the stream. The nature of these banks is stated to be invariably a heavy clay, which material also forms the bed of the river. The height of these banks varies from ten to twelve feet.

D.—TIMBER AND VEGETATION.

A large percentage of the land throughout the drainage basin of the river in the province of Manitoba is cultivated, and there is a very small amount of standing timber. What there is consists mostly of small elm, ash and oak, very little of which is large enough to have commercial value except as firewood.

E.—SETTLEMENTS.

In the course of the river through Manitoba, three settlements are met with. The first located close to the head-waters is the village of Sprague on the Ridgeville branch of the C.N.R. The second is Stuartburn, on the same line of railroad. The third is Dominion City, located at the crossing of the C.P.R., Emerson branch. These villages are all small, the largest being Dominion City, with a population of about two hundred.

F.—RUN-OFF.

(*a*) *Rainfall.*—From rainfall records of the northern part of Minnesota covering a period of thirty years and at Oak Bank, to the north of the drainage area, covering a period of twenty-two years, it is found that the mean annual precipitation in the watershed of the Roseau is 22 inches.

(*b*) *Discharge Measurements.*—A metering station was established on the river at Dominion City by the Manitoba Hydrographic Survey in May, of 1912. During the summer of that year and the winter of 1912-13, nine discharge measurements were made, the results of which are shown in table No. 31.

This station was abandoned during the spring of the present year to escape the effects of backwater from a dam placed below the metering section by the C.P.R., for water-supply purposes.

In April of 1913 the same survey established a metering station on Baskerville's traffic bridge, about twenty-five miles upstream from Dominion City, and observations, including daily gauge height records and discharge measurements, have been made at this point during the present season. These discharge measurements, eight in number, are shown in table No. 33.

The estimated daily discharges, based on the above-mentioned discharge measurements for the stations at Dominion City and Baskerville's Bridge, will be found in tables No. 32 and No. 39.

C.—POWER POSSIBILITIES.

No surveys for the purpose of locating power sites have been made on this river, and information as to the possibility of concentrating the natural fall at any points throughout its course is very meager. Local authority reports that in the neighbourhood of Dominion City there is a possible development of 15 feet head, but this has not been investigated.

From the village of Sprague, near the head-waters to Dominion City, a distance of about two hundred miles by river, there is a difference in elevation of 287 feet, or about 1·4 feet to the mile.

Should any development be made on this river, and a continuous supply of power be required, it would necessitate the installation of an auxiliary steam plant to carry it over points of extreme low flow, as the absence of lakes or storage areas in the upper reaches of the river make the possibility of storage regulation very slight.

II.—WATER-POWER.

From the estimates of flow for the year ending October 31, 1913, it will be seen that during the months of February and March the flow was entirely cut off, and the following table gives the power available per foot of head at an 80 per cent efficiency, based on the lowest monthly mean flow (40 second-feet), for the open six months of the year, viz., from May to October. This estimate of power only relates to the period as stated.

Head in Feet.	Estimated Horse-power at 80 per cent Efficiency.
	Flow 40 Sec.-ft. Period May to October.
1	3·6
10	36
20	72

TABLE No. 31.

DISCHARGE MEASUREMENTS of Roseau River at Dominion City, 1912.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
1912.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
May 21..	S. S. Scovil...	1187	81·0	334·2	1·22	3·79	408
June 18..	G. H. Burnham.	1187	73·5	238·9	0·65	2·42	155
July 11..	G. H. Burnham.	1187	68·0	123·5	0·252	0·95	31
Aug. 7..	W. G. Worden.	1187	74·6	216·1	0·634	2·225	137
" 24..	W. G. Worden.	1187	72·1	199·3	0·515	1·975	103
Oct. 19..	G. J. Lamb.	1187	85·0	553·0	2·16	6·85	1195
Nov. 1..	G. J. Lamb.	1187	85·5	581·8	2·19	7·00	1273
1913.							
Jan. 13..	G. J. Lamb.	1374	56·0	25·2	·93	2·78	23·5 [1]
Feb. 25.	A. Pirie						0 [2]

[1] Ice measurement. [2] No flow; frozen to bottom.

TABLE No. 32.

DAILY GAUGE HEIGHT AND DISCHARGE, Roseau River at Traffic Bridge, Dominion City, for 1912.

Day.	May.		June.		July.		August.		September.		October.		November.		December.	
	Gauge Height.	Discharge	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	......	......	3·79	410	1·14	41	1·74	83	1·96	103	4·43	577	7·01	1248	3·42	
2	......	......	3·50	336	1·04	36	1·90	97	1·97	104	4·65	634	6·80	1193	3·22	
3	......	......	3·53	344	1·02	35	2·05	113	2·02	109	4·81	676	6·60	1141	2·73	
4	......	......	3·52	341	1·02	35	2·13	121	2·20	129	4·91	702	6·50	1115	2·35	
5	......	......	3·42	318	0·97	33	2·16	125	2·24	133	5·03	733	6·16	1027	2·88	
6	......	......	3·48	332	0·93	30	2·22	131	2·20	129	5·91	962	5·81	936	2·63	
7	......	......	3·41	316	1·02	35	2·23	132	2·22	131	5·27	795	5·61	884	2·82	
8	......	......	3·35	304	0·96	32	2·18	127	2·18	127	5·44	839	5·52	860	2·78	
9	......	......	3·29	292	1·08	38	2·03	110	2·17	126	5·44	839	5·43	837	2·58	
10	......	......	3·21	276	1·11	40	1·94	101	2·22	131	5·61	884	5·31	806	2·54	
11	......	......	3·14	263	0·95	31	1·83	91	2·23	132	5·81	936	5·24	787	2·37	
12	......	......	3·00	238	1·19	44	1·83	91	2·14	122		1000	5·11	754	2·11	
13	......	......	2·98	235	1·18	44	2·03	110	2·17	126	Water above gauge.	1039	4·98	720	1·91	
14	......	......	2·90	222	1·30	51	2·11	119	2·20	129		1060	4·80	673	1·77	
15	......	......	2·85	214	1·41	59	2·17	126	2·23	132		1090	4·87	691	1·70	
16	......	......	2·76	200	1·54	68	2·14	122	2·25	134		1120	5·20	777	1·61	
17	......	......	2·63	182	1·58	71	2·18	127	2·24	133		1150	5·42	834	1·56	
18	......	......	2·49	163	1·58	71	2·20	129	2·25	134		1180	4·71	650	1·51	
19	......	......	2·20	129	1·61	73	2·20	129	2·24	133	6·87	1211	5·11	754	1·47	
20	3·78	408	2·28	138	1·66	77	2·23	132	2·35	146	6·78	1188	5·27	795	1·46	
21	3·79	410	2·17	126	1·71	81	2·23	132	2·59	177	6·92	1224	5·14	761	1·45	
22	3·79	410	2·00	107	1·78	86	2·16	125	2·83	211	7·08	1266	5·87	951	1·43	
23	3·81	416	1·88	95	1·85	93	2·05	113	2·88	219	7·01	1248	5·06	741	1·43	
24	3·77	405	1·74	83	1·91	98	1·97	104	2·91	224	7·13	1279	4·78	668	1·43	
25	3·71	390	1·63	74	1·82	90	1·94	101	2·98	235	7·31	1326	4·93	707	1·43	
26	3·64	371	1·51	66	1·72	82	1·91	98	3·22	278	7·20	1297	......	640	1·43	
27	3·67	379	1·43	60	1·64	75	1·89	96	3·44	323	7·21	1300	......	580	1·43	
28	3·82	418	1·33	53	1·64	75	1·92	99	3·69	381	7·20	1297	4·24	527	2·48	
29	4·01	468	1·20	45	1·73	82	1·93	100	3·97	457	7·38	1344	3·81	416	3·11	
30	4·01	468	1·20	45	1·69	79	2·03	110	4·24	527	7·42	1354	3·63	369	3·01	
31	3·92	444	......	......	1·71	81	2·09	117	......	......	7·11	1274	......	......	2·98	

TABLE No. 38.

DISCHARGE MEASUREMENTS of Roseau River, at Baskerville's Bridge, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Apr. 12	G. H. Burnham	1196	....	183·7	2·16	8·00	1,011
" 23	A. Pirie	1186	....	910·3	2·25	12·51	2,014
" 30	E. Bankson	1469	....	647·3	2·42	10·88	1,560
May 14	E. Bankson	1469	....	351·5	1·69	6·01	560
June 28	G. Ebner	1186	....	145·6	0·88	2·94	128
July 31	A. Pirie	1196	....	165·6	1·03	2·90	171
Aug. 20	C. O. Allen	1135	....	94·0	0·44	1·55	42
Sep. 18	C. O. Allen	1135	....	105·1	0·54	1·72	57

TABLE No. 34.

Daily Gauge Height and Discharge, Roseau River, near Baskerville's Bridge, for 1913.

Date.	April. Gauge Height.	April. Discharge.	May. Gauge Height.	May. Discharge.	June. Gauge Height.	June. Discharge.	July. Gauge Height.	July. Discharge.	August. Gauge Height.	August. Discharge.	September. Gauge Height.	September. Discharge.	October. Gauge Height.	October. Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	10·46	1517	3·98	264	3·28	186	2·65	126	2·32	97	1·41	33
2	....	....	9·85	1389	·87	250	·10	168	·51	113	·23	89	·40	32
3	....	....	·74	1365	·80	242	·03	161	·41	101	·15	83	·40	32
4	....	....	·49	1313	·79	241	·08	166	·30	95	·08	77	·39	31
5	....	....	·04	1218	·78	240	·08	166	·20	87	·06	76	·41	33
6	....	....	8·47	1099	3·88	252	2·99	157	2·09	78	2·01	72	1·48	33
7	....	....	·03	1006	·77	239	·92	150	1·92	65	1·92	65	·52	39
8	....	....	7·68	933	·79	241	·96	154	·89	63	·81	58	·55	41
9	....	....	·29	851	·93	258	·85	144	·78	56	·70	50	·51	39
10	....	....	·03	796	·97	262	·77	136	·68	49	·89	65	·52	39
11	....	....	6·74	735	3·98	264	2·88	146	1·71	51	1·79	56	1·60	44
12	....	....	·55	696	4·00	266	·97	155	·61	45	·72	51	·75	54
13	....	....	·27	637	·00	266	3·08	166	·59	43	·68	49	·84	60
14	....	....	5·96	572	·07	274	2·99	157	·54	40	·67	48	·80	57
15	....	....	·99	578	·07	274	·99	157	·49	37	·67	48	2·29	....
16	....	....	5·96	572	3·97	262	3·09	167	1·52	39	1·67	48	2·60	....
17	....	....	·63	510	·79	241	·90	254	·39	31	·61	45	·74	....
18	....	....	·40	469	·77	239	·32	190	·39	31	·79	56	·99	....
19	....	....	·24	440	·73	234	·40	198	·41	33	·78	56	·88	....
20	....	....	·17	428	·63	223	·41	199	·47	36	·79	56	·81	....
21	....	....	5·11	419	3·46	205	3·45	204	1·79	56	1·71	51	2·62	....
22	....	....	·03	406	·29	187	·49	208	·63	46	·71	51	·40	....
23	12·54	1953	4·89	384	·19	177	·41	199	·71	51	·68	49	·59	....
24	·48	1941	·74	363	·09	167	·39	197	·71	51	·71	51	·63	....
25	·69	1985	·69	356	·02	160	·36	194	·85	61	·68	49	·61	....
26	11·99	1838	4·58	340	2·78	137	3·30	188	2·05	76	1·63	46	2·42	....
27	·46	1727	·44	322	·69	129	·23	181	·15	108	·59	43	·41	....
28	·69	1775	·29	303	3·39	197	·13	171	·52	114	·51	39	·34	....
29	·39	1712	·24	296	·31	189	·01	159	·52	114	·47	36	·65	....
30	10·96	1622	·19	290	·56	216	2·98	156	·47	109	·42	33	·03	....
31	....	....	·05	272	....	....	·87	145	·38	101	....	....	·60	....

THE RED RIVER.

A.—LOCATION.

The source of the Red river is in the western central part of the state of Minnesota. Its first flow is in a southerly direction for a distance of sixty miles, then to the west for one hundred miles to the town of Breckenbridge, on the boundary line between the states of Minnesota and North Dakota. From this town to the international boundary the river forms the dividing line between the two above-mentioned states. Continuing in its course through Manitoba the river empties into the southern part of lake Winnipeg.

B.—DIRECTION.

The general direction of the river, after passing its first flow to the south and west, as above noted, is almost directly north and, from the town of Breckenbridge to the city of Winnipeg, a distance of two hundred and fifty miles, the general course of the river does not vary from a straight line more than five miles. At Winnipeg it bears away to the eastward, and the final thirty-five miles of its course lie in a north-easterly direction.

An idea of the extremely winding nature of the river can be gathered from the fact that in its course from Breckenbridge to Winnipeg, though the general course does not vary to any great extent from a straight line, yet the length of the actual river channel is more than double the distance by direct line. This characteristic is common throughout its length.

C.—RIVER BASIN.

The drainage basin of the river covers an area of 116,347 square miles, of which 42,517 are in Minnesota and Dakota, 50,500 in Saskatchewan and 23,300 in Manitoba.

A large part of this area is made up by the area of its largest tributary, the Assiniboine river.

The principal tributaries entering the river in Manitoba are the Roseau, the Rat and the Seine, from the east, and the Assiniboine and Morris rivers from the west. The Pembina river, though the greater part of its drainage area lies in southern Manitoba, joins the Red south of the international boundary.

D.—BED AND BANKS.

The entire basin is practically a level plain, varying in width from 50 to 200 miles, and with a length of water over 300 miles. There is a gentle slope from the sides of the valley to the center, of about the same gradient as from the head-waters to the mouth of the river, namely, about one foot to the mile. Down the center of the valley the river has cut a sharp, winding channel, dropping from twenty to fifty feet below the level of the plains on either side. The banks of this channel are composed of a gravelly clay, and though no rock outcrops show in the course of the river, the bed, close to the mouth, is underlaid with a stratum of rocks at a depth varying from ten to twenty feet.

E.—TIMBER AND VEGETATION.

Throughout the Red River valley lying in Manitoba there is very little standing timber except in the extreme easterly section of same. Along the course of the river, occasional clumps of elm and ash are met with, though not of sufficient extent to warrant extensive lumbering operations.

The land being mostly prairie, and being along the line of first immigration into Manitoba, naturally it is one of the oldest settled districts in the province. The larger percentage of the land is settled and is continuously worked as farm land, it being of a very productive nature.

F.—NAVIGATION.

The river is navigable for boats of light draught from the mouth of the river up to Grand Forkes, Minn. Prior to the construction of the railroads it was used extensively during the open season for freight and passenger service. Since the coming of the railroads, however, river traffic could not compete with this faster mode of transportation, and has gradually died out.

There has been a considerable revival in river travel in the lower reaches of the river since the installation, by the Dominion Government, of the St. Andrews dam and locks near the mouth of the river. This dam, which raises the water level at Winnipeg about eight feet, ensures the boats from lake Winnipeg a safe passage up the river to the city during the summer months.

G.—SETTLEMENTS.

In the course of the river through Manitoba, the first town passed through is Emerson, located at the international boundary, and from this point to Winnipeg there are located a number of smaller towns. These towns are in some instances removed a mile from the river, being located on the C.N.R., which line closely parallels the course of the river for the entire distance. Between the city of Winnipeg and the mouth of the river the largest town is Selkirk, located about 22 miles below the city, but there are small settlements scattered throughout almost the entire distance.

H.—RUN-OFF.

(a) *Rainfall.*—From records in central Minnesota covering a period of thirty years, it is found that the mean annual precipitation at the head-waters of the river is 24 inches, and the records at Winnipeg, covering a period of forty years, give the mean annual rainfall at that point to be 21 inches.

In the western part of the drainage area of the river, the rainfall is noticeably less than that noted above, and does not average more than 17 inches.

(b) *Discharge Measurements.*—A metering station was located on the river at the town of Emerson, in May of the year 1912, and during the years of 1912 and 1913, nineteen discharge measurements were made at different stages of the river. The results obtained from these measurements are shown in table No. 35.

A continuous record of gauge heights has also been kept since this station was established, and these with the estimated daily discharges, are shown in tables No. 36 and No. 37.

I—HIGH AND LOW FLOW.

The rise and fall of stage in the Red river throughout the year is, as a rule, gradual, with the exception of during the spring break-up. At this time there are liable to be excessive floods. These floods are caused by the release of the water held in the form of snow and ice in the warmer southern reaches of the river, some time previous to the break-up in the colder sections near the mouth. As it reaches the section of the river where the break-up has not yet taken place, this water, not being able to obtain easy egress, backs up and frequently forces the stage of the river to a height of 20 to 30 feet above normal water level.

J.—WATER-POWER.

In the course of the river through the province the only feasible power development is located at Lockport, where the construction of the Dominion Government dam at the St. Andrews rapids has concentrated a head of approximately 15 feet.

Any development at this point would necessarily be for operation only during the period of open water on the river, when the dam is held closed as an aid to navigation, usually between the months of May and October.

The following table gives the estimated power available at this site, based on an 80 per cent efficiency. The discharge on which this table is based is an estimated low flow of 2,400 second-feet, and has been arrived at from the information at hand as to the lowest mean monthly flow of the river as it enters the province and of the tributaries entering the river in its course between Emerson and Lockport. This discharge is estimated only for six months ending October 31, 1913, and is subject to revision.

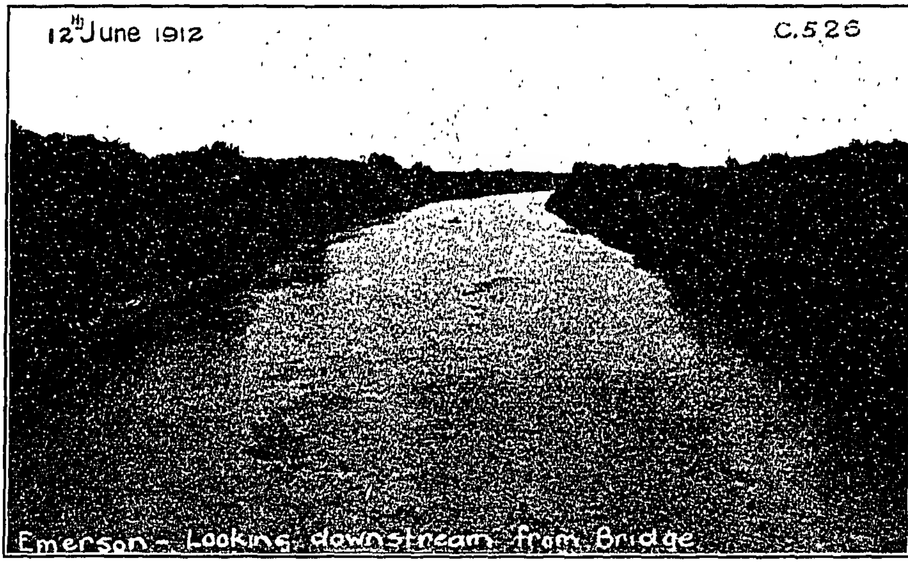
Head in Feet.	Estimated Horse-Power at 80 Per Cent. Efficiency.
	Minimum Flow 2,400 sec.-ft. Period May to December.
15	3,270

TABLE No. 35.

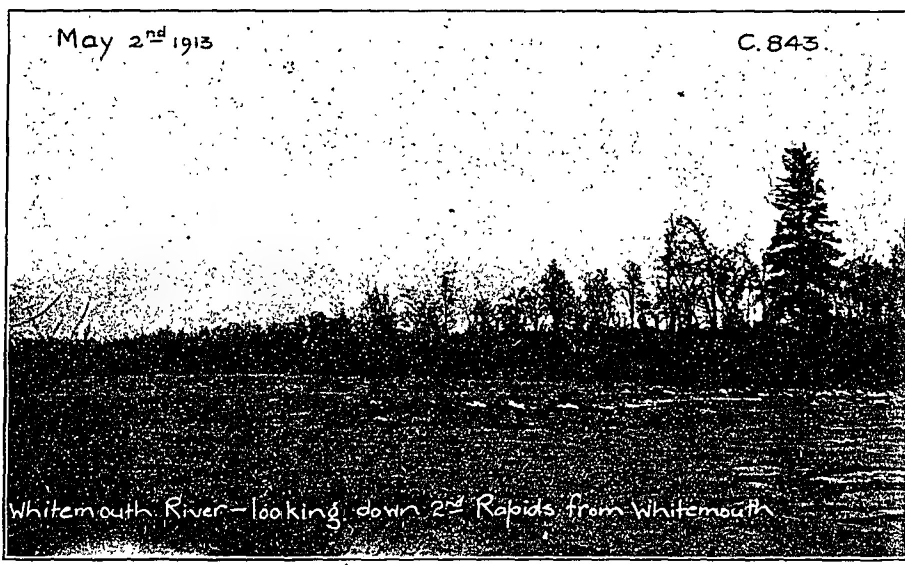
Discharge Measurements of Red River, at Emerson, 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Average of Section.	Mean Velocity.	Gauge Height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
1912.							
May 3..	S. S. Scovil	1187	222.2	876	1·88	4·00	1646
" 18	S. S. Scovil.	1187	245	1353	2·25	6·46	3045
June 12..	G. H. Burnham	1187	243	885	1 92	4·26	1699
" 15..	G. H. Burnham	1187	243	852	1·62	3·68	1380
July 9..	G. H. Burnham	1187	214	649	1 53	2·73	994
" 24..	G. H. Burnham	1187	213	682	1·70	3·09	1159
Aug. 6..	W. G. Worden	1187	214	679	1·74	3 05	1183
" 22.	W. G. Worden	1187	214	672	1·59	2 60	1070
Oct. 18..	G. J. Lamb	1187	242	1038	1·69	4·73	1754
" 31.	G. J. Lamb.	1187	221	881	1·63	4·06	1436
1913.							
Jan. 15..	G. J. Lamb.	1375	190	754	·66	2·55	500[1]
Feb. 24..	A. Pirie	1462	185	625	·45	2 14	278[1]
Apr. 10..	G. H. Burnham	1497	357	7190	3·37	28·65	24233
" 22..	A. Pirie	1186	304	3645	2 81	17·10	10230
" 29..	E. Bankson	1469	270	2437	2·44	11·47	5936
May 13..	E. Bankson	1469	244	1333	2·41	6·95	3211
July 30..	A. Pirie	1469	243	638	1·59	2·69	1015
Aug. 19..	C. O. Allen	1435	220	492	1 62	2·23	797
Sep. 19..	C. O. Allen	1435	222	751	1 96	3·73	1524

[1]Ice measurement taken 2½ miles below station.



Emerson – Looking downstream from Bridge



Whitemouth River – looking down 2nd Rapids from Whitemouth

TABLE No. 36.

DAILY GAUGE HEIGHT AND DISCHARGE, Red River, at Emerson, for 1912.

Day.	May.		June.		July.		August.		September.		October.		November.		December.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	1500	6·0	2650	3·4	1293	4·3	1715	2·53	942	6·5	2950	3·95	1542	3·15	
2	....	1525	5·86	2569	3·14	1184	4·0	1565	2·45	911	6·95	3225	3·95	1496	3·6	
3	3·98	1556	5·76	2511	3·0	1125	3·62	1390	2·38	886	7·3	3141	3·8	1473	3·8	
4	4·02	1575	5·62	2430	2·9	1086	3·3	1251	2·26	841	7·5	3565	3·85	1496	3·75	
5	4·23	1680	5·5	2360	2·79	1043	3·2	1209	2·35	875	7·35	3472	3·85	1496	3·7	
6	4·2	1665	5·38	2293	2·79	1043	3·09	1163	2·35	875	·72	3379	3·9	1519	3·65	
7	4·35	1740	5·26	2226	2·7	1008	3·05	1146	2·75	1028	·70	3255	3·85	1496	3·63	
8	4·5	1815	5·12	2147	2·6	969	2·94	1102	2·8	1047	6·7	3072	3·8	1472	3·6	
9	4·65	1895	4·95	2054	2·73	1020	2·69	1004	2·65	988	6·35	2860	3·8	1473	3·5	
10	4·8	1974	4·6	1868	2·72	1016	2·59	965	2·46	915	5·95	2621	3·8	1473	3·4	
11	5·23	2209	4·4	1765	2·7	1008	2·5	930	2·5	930	5·7	2476	3·8	1473	3·3	
12	5·56	2395	4·25	1690	2·69	1004	2·55	950	2·55	950	5·5	2360	3·8	1473	3·15	
13	6·08	2698	4·09	1610	2·8	1047	2·52	938	2·48	923	5·4	2304	3·85	1496	3·15	
14	6·29	2824	3·9	1519	2·65	988	2·45	911	2·32	863	5·3	2248	3·85	1496	3·15	
15	6·43	2908	3·74	1445	2·65	988	2·36	878	2·26	841	5·2	2192	3·75	1450		
16	6·48	2938	3·59	1376	2·68	1000	2·4	893	2·35	875	4·9	2027	3·7	1427		
17	6·47	2932	3·54	1353	2·68	1000	2·37	882	2·48	923	4·8	1974	3·6	1381		
18	6·47	2932	3·53	1349	2·7	1008	2·26	841	2·65	9·8	4·62	1879	3·6	1381	3·0	
19	6·45	2920	3·53	1349	2·73	1020	2·33	867	2·88	1078	4·57	1852	3·6	1381		
20	6·32	2842	3·53	1349	2·73	1020	2·60	969	3·0	1125	4·45	1790	3·5	1335		
21	6·25	2800	3·53	1349	2·8	1047	2·78	1039	3·08	1159	4·4	1765	3·4	1293	3·0	
22	6·0	2650	3·53	1349	2·9	1086	2·76	1031	3·05	1146	4·3	1715	3·29	1247		
23	5·9	2592	3·53	1349	3·0	1125	2·60	969	3·1	1167	4·15	1640	3·18	1201	2·9	
24	5·8	2534	3·51	1340	3·09	1163	2·50	930	3·3	1251	4·0	1565	3·27	1238		
25	5·7	2476	3·56	1363	3·15	1188	2·40	893	3·5	1335	3·9	1519	3·35	1272		
26	5·5	2360	3·63	1395	3·13	1180	2·48	923	3·65	1404	3·8	1473	3·4	1293	2·8	
27	5·68	2461	3·74	1445	3·3	1251	2·55	950	3·75	1450	3·8	1473	3·45	1314		
28	5·97	2633	3·87	1505	3·3	1251	2·47	923	4·0	1565	3·9	1519	3·45	1314		
29	6·05	2680	3·8	1473	3·22	1217	2·36	878	4·5	1815	4·0	1565	3·45	1314		
30	6·08	2698	3·64	1399	4·15	1640	2·30	856	5·6	2418	4·1	1615	3·4	1293		
31	6·10	2710	......	....	4·68	1910	2·49	926	....	....	4·0	1565				

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE,

Day.	January.		February.		March.		April.		May.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	2·8	...	...	...	...	...	4·2	1665	10·15	5230
2	...	...	...	...	...	...	5·2	2192	9·95	5103
3	...	...	...	...	...	...	7·0	3255	8·7	4316
4	2·7	...	...	...	...	...	8·6	4253	8·5	4190
5	...	...	2·45	...	2·13	...	10·6	5514	8·4	4127
6	...	...	...	...	...	...	18·15	10925	8·3	4064
7	...	...	...	...	...	...	22·15	14863	8·0	3875
8	2·6	...	...	...	...	...	25·15	18597	7·8	3751
9	...	...	...	...	...	...	27·15	21591	7·6	3627
10	...	...	...	...	...	...	28·45	23906	7·4	3503
11	...	...	...	...	...	...	29·45	26020	7·2	3379
12	...	...	2·2	...	2·13	...	29·45	26020	7·1	3317
13	...	...	...	...	...	...	29·15	25360	6·9	3194
14	2·55	...	...	...	...	...	28·55	24103	6·8	3133
15	...	...	...	...	...	...	27·55	22255	6·6	3011
16	...	...	...	...	...	...	26·55	20633	6·5	2950
17	...	...	...	...	...	...	25·55	19163	6·4	2890
18	2·53	...	...	...	...	...	24·05	17115	6·3	2830
19	...	...	2·15	...	2·13	...	22·80	15603	6·2	2770
20	...	...	...	...	...	...	21·15	13793	6·1	2710
21	...	...	...	...	...	...	19·15	11825	6·0	2650
22	2·5	...	...	...	...	...	17·45	10337	6·0	2650
23	...	...	...	...	...	...	16·15	9304	5·9	2592
24	...	...	...	...	...	...	14·85	8354	5·9	2592
25	...	...	...	...	...	...	13·85	7651	5·85	2563
26	...	...	2·14	...	2·13	...	12·85	6971	5·7	2476
27	...	...	...	...	...	...	12·15	6513	5·55	2389
28	...	...	...	...	...	...	11·15	5866	5·5	2360
29	2·5	...	...	...	...	...	10·45	5419	5·4	2304
30	...	...	...	...	...	...	10·35	5355	5·4	2304
31	...	...	...	...	3·9	...	...	...	5·35	2276

No. 37.

Red River, at Emerson, for 1913.

June.		July		August.		September.		October.		
Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Day.
Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	
5·3	2248	3·25	1230	2·55	950	2·94	1102	2·62	977	1
5·2	2192	3·3	1251	2·6	969	3·0	1125	2·60	969	2
5·12	2147	3·3	1251	2·68	1000	2·8	1047	2·46	915	3
5·1	2136	3·27	1238	2·78	1039	2·72	1016	2·20	819	4
5·0	2080	3·25	1230	2·95	1106	2·6	969	2·20	819	5
4·95	2054	3·22	1217	3·2	1209	2·5	930	2·23	830	6
4·93	2043	3·12	1175	2·92	1094	2·43	904	2 27	845	7
4·9	2027	3·1	1167	2·87	1074	2·37	882	2 35	875	8
4·85	2000	3·0	1125	2·57	957	2·23	830	2·45	912	9
4·8	1974	3·0	1125	2·56	953	2·1	782	2·53	942	10
4·77	1957	2·9	1086	2·55	950	2 2	819	2·60	969	11
4·7	1921	3·17	1196	2·5	930	2·23	830	2·67	996	12
4·65	1895	3·4	1293	2·5	930	2·2	819	2·75	1027	13
4·55	1841	3 8	1473	2·4	893	2·4	893	2.90	1086	14
4·45	1790	4·2	1665	2·3	856	2·7	1008	3·15	1188	15
4·35	1740	4·4	1765	2·2	819	2·97	1115	3·40	1293	16
4·22	1675	4·3	1715	2·1	782	3·4	1293	3·63	1395	17
4·12	1625	4·25	1690	2·1	782	3·7	1427	3 74	1445	18
4·0	1565	4·1	1615	2·2	819	3·73	1441	3·74	1445	19
3·85	1496	3·95	1542	2·2	819	3·8	1473	3·80	1473	20
3·75	1450	3·75	1450	2·27	845	3·9	1519	3·76	1455	21
3.7	1427	3·7	1427	2·3	856	4·0	1565	3·70	1427	22
3·65	1404	3·62	1390	2·35	875	4·1	1615	3·70	1427	23
3·62	1390	3·58	1372	2·4	893	3·9	1519	3·70	1427	24
3·58	1372	3·4	1293	2·3	856	3·7	1427	3·60	1381	25
3·53	1349	3·34	1268	2·27	845	3·5	1335	3 50	1335	26
3 5	1335	3·12	1175	2·38	886	3·3	1251	3·45	1314	27
3·4	1293	3·0	1125	2·5	930	3·0	1125	3·40	1293	28
3·3	1251	2 8	1047	2·6	969	2·9	1086	3·31	1255	29
3·28	1243	2·67	996	2 85	1066	2·75	1028	3·15	1188	30
... .	. ....	2·6	969	2·8	1047	....	....	3·20	1209	31

The Pembina River.

A.—Location and Direction.

The head-waters of the Pembina river are found on the northeasterly slopes of Turtle mountain, from which the river flows in a winding easterly direction. Fifty miles above its mouth the river bends southward, crossing the international boundary, then turning again to the east flows into the Red river about five miles south of Emerson.

B.—River Basin.

The basin of the river covers an area of 4,180 square miles, 1,440 of which are in Dakota; the balance, 2,740, in southern Manitoba.

In the upper reaches of the river basin there are located numerous small lakes and sloughs, and it is in this section that most of the drainage is obtained. One notable feature of the watershed is the fact that practically all of the drainage enters the river from the south, the tributaries entering from the north being small and having very little flow except in the early spring or times of excessive rains.

The principal tributaries are the Whitemud river, Long river, Beaver creek and Snowflake creek, all flowing from the south.

C.—Bed and Banks.

The lower forty miles of the course of the river lie in flat level country, typical of the Red River valley. The banks of the stream cut sharply down from the level of the prairie to a depth of from twenty to forty feet. The conformation of the banks in this section is principally a sandy clay, which also constitutes the bed of the river.

After the above distance is traversed, the nature of the valley changes, the banks becoming bolder and rising to a height varying from 175 feet to 450 feet. The nature of the soil in the valley also changes, being much more sandy, and the flats and bed of the river are composed of sandy gravel and strewn with boulders.

D.—Width.

The average width of the river is approximately ninety feet, but in the middle reaches it widens out in several places, forming lakes varying in width from half a mile to a mile and a half. The more important of these lakes are Swan lake and Rock lake, these being six and nine miles, long respectively

E.—Transportation and Accessibility.

The Pembina river is not navigable, but, flowing through a well-settled country, it is easily accessible from good roadways, and also from railroads which cross it at many points in its winding course from mouth to head-waters.

F.—Run-off.

(*a*) *Rainfall.*—The mean annual rainfall at the mouth of the river is 20 inches. This decreases as the course of the river is followed upwards, and at the head-waters the yearly average is 14 inches. This low rainfall has a decided effect on the flow, as it is in this locality that most of the drainage enters the river, and in times of drought the discharge is cut down to an extremely low figure.

(*b*) *Discharge Measurement.*—For some years the United States Geological Survey has made observations as to flow on the Pembina river at Neche, North Dakota, and from the report of these, *see* tables No. 38 to No. 42, it will be seen that there is a large variation in the flow of the river, the mean monthly discharge ranging from the

low flow of 3 second-feet during the months of August, September and October, in the year 1910, to a high flow of 3,870 in May of 1904.

F.—WATER-POWER.

There is no information at hand as to any surveys having been made on the river for the purpose of locating water-power sites, but the nature of the valley and the natural fall of the river point to the possibility of there being such in its course.

The fall of the river from the base of Turtle mountain to the point where the valley opens out into the valley of the Red river is 700 feet or approximately 3 feet per mile.

The low flow of the river is extremely small, and any power development depending on the natural flow would be subject to serious interference through lack of water for a considerable period of the year.

A certain amount of storage could be obtained on the lakes in the course of the river, and also on Pelican lake, which is about two miles distant from the river channel. Whether or not this storage would be sufficient to carry any development over the period of low flow is very uncertain.

TABLE No. 38.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1903.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-feet.			Run-off
	Maximum.	Minimum.	Mean.	Total in Acre-feet.
April				
May			202	12,420
June	198	110	149	8,866
July	110	35	60	3,689
August			35	555
September				
October			42	1,749
November			42	1,156
December				
The period				

NOTE—Obtained from records of Water Resources Branch, U.S. Geological Survey.

TABLE No. 39.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1904.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per Square Mile.	Depth in Inches on dr'n'ge area.	Total in Acre-feet.
April	3,580	217	1,920	0·653	0·56	87,600
May	3,870	1,420	2,640	·898	1·04	162,000
June	2,530	926	1,690	·575	·64	101,000
July	2,690	399	839	·285	·33	51,600
August	420	315	385	·131	·15	23,700
September	315	236	302	·103	·11	18,000
October	275	217	235	·080	·09	14,400
November	217	131	183	·062	·06	9,440
December	.....	.....	.....	.....	.....	.....
The period	.....	.....	.....	.....	.....	468,000

NOTE.—Obtained from records of Water Resources Branch, U.S. Geologicol Survey.

TABLE No. 39A.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1905.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in acre-feet.
March 23-31	672	530	606	0·216	0·072	10,820
April	1,372	311	549	·196	·219	18,510
May	1,180	218	447	·160	·184	27,480
June	1,180	279	485	·173	·193	16,600
July	399	119	206	·074	·085	12,670
August	137	60	97	·035	·040	5,964
September	119	65	93.9	·034	·038	5,587
October	150	70	119	·042	·048	7,317
November 1-26	137	91	116	·041	·040	5,982
The period	.....	.....	.....	.....	.....	110,900

NOTE.—Obtained from records of Water Resources Branch, U.S. Geological Survey.

TABLE No. 40.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1906.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in acre-feet.
April	1220	193	479	0·163	0·18	28,500
May	231	175	193	·066	·08	11,900
June	340	193	271	·092	·10	16,100
July	270	119	175	·060	·07	10,800
August	143	119	131	·045	·05	8,060
September	166	136	147	·050	·06	8,750
October	150	136	144	·049	·06	8,850
November	136	82	111	·038	·03	4,180
The period						97,100

NOTE.—Obtained from records of Water Resources Branch, U. S. Geological Survey.

TABLE No. 40A.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1907.

[Drainage area, 2,940 square miles.]

Month.	Discharge in Second-feet.				Run off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in acre-feet.
April 21-30			860	0·293	0·11	17,100
May	2,190	826	1600	·544	63	98,400
June	805	263	507	·172	·19	30,200
July	272	76	156	·053	·06	9,590
August	80	36	54·3	·014	·02	3,340
September	47	23	34·8	·012	·01	2,070
October	66	36	55·2	·019	·02	3,390
November			38·0	·013	·01	2,260
December			19·0	·006	·01	1,170
The period						168,000

NOTE.—Obtained from records of Water Resources Branch, U.S. Geological Survey.

TABLE No. 40B.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1908.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-feet.				Run off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in acre-feet.
January	....	... ...	6	·002	·002	369
February	....	....	3	·001	·001	178
March	....	....	3	·001	·001	184
April	927	....	375	·128	·14	22,300
May	591	310	474	·161	·19	29,100
June	486	136	224	·076	·08	13,300
July	136	36	87·8	·030	·03	5,400
August	66	36	52·1	·018	·02	3,200
September	78	55	60·9	·021	·02	3,620
October 1-10	55	45	49·0	·017	·006	972
The year period	....	.. ..	....	.. ..	... .	78,600

NOTE.—Obtained from records of Water Resources Branch, U.S. Geological Survey.

TABLE No. 41.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1909.

[Drainage area 2,940 square miles.]

Month.	Discharge in Second-Feet.				Run off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in Acre-feet.
June	654	268	427	0·145	0.07	11,000
July	164	73	113	·038	.04	5,600
August	100	22	48·3	·016	.02	2,970
September	32	22	27·7	·0094	.01	1,650
October	73	32	45·9	·016	.02	2,970
November	67	38	51·9	·018	.009	1,440

NOTE.—Obtained from records of Water Resources Branch, N.S. Geological Survey.

TABLE No. 42.

MONTHLY DISCHARGE of Pembina River, at Neche, North Dakota, for 1910.

[Drainage area, 2,910 square miles.]

Month.	Discharge in Second-Feet.				Run off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on dr'n'ge area.	Total in Acre-feet.
March	685	115	349	0·118	0·08	11,800
April	250	147	166	·056	·06	9,880
May	164	86	120	·041	·05	7,380
June	100	7	60·4	·020	·02	3,590
July	100	10	34·9	·012	·01	2,150
August	10	3	6·87	·0023	·003	422
September	7	3	3·93	·0013	·001	234
October	10	3	6 39	·0022	·003	393

NOTE.—Obtained from records of Water Resources Branch, U.S. Geological Survey.

THE SOURIS RIVER.

A.—LOCATION AND DIRECTION.

The source of the Souris river lies in the southern part of the province of Saskatchewan, its head-waters being about 20 miles northwest of the town of Weyburn.

The upper course of the river is in a southeasterly direction, down into the state of North Dakota, where it bends to the northeast, and this general course is followed until it joins the Assiniboine river, about 22 miles southeast of the city of Brandon.

B.—RIVER BASIN.

The basin of the Souris is probably larger in comparison with its flow than any other western river, it covering an area of 22,860 square miles. The extreme width of same is 160 miles and the length from head-waters to mouth 200 miles.

The length of the river itself, considering its windings, is nearly 550 miles, with a width varying from 85 to 170 feet.

The upper part of the basin in Manitoba consists, in the greater part, of a sandy or gravely substratum, overlaid with a light alluvial soil. The valley in this district is shallow but, as it nears the mouth of the river, the soil becomes heavier and the valley much bolder, with steep banks rising to a height of 150 to 200 feet in some localities. The banks of the stream itself vary from 20 to 30 feet in height, and consist of sand, gravel and clay. The land above the banks of the valley is, as a rule, bald prairie with very little timber showing, all of which is small and in isolated clumps.

C.—HIGH AND LOW WATER.

The difference between high and low water of the river in some districts has been noted as being 20 feet, but this is an extreme condition, the normal variations being about 10 or 12 feet.

D.—SETTLEMENTS.

Throughout the basin of the river in Manitoba, the country is well settled, and several thriving towns are noted along the course of the river itself, among them being Wawanesa, Souris, Hartney and Melita.

E.—TRANSPORTATION AND ACCESSIBILITY.

The river is not navigable except by row-boat or canoe, and difficulty would be experienced in travelling even by them in the low stages.

Passing through a well-settled country with a soil which tends to be of rather a sandy nature, the roads are good and the river easily accessible therefrom at many points. It is also in close touch with railroads throughout its entire length. From the town of Souris, the Estevan branch of the C.P.R. closely follows the course of the river to within a short distance of the point at which it flows across the international boundary from the state of North Dakota.

F.—RUN-OFF.

(*a*) *Rainfall.*—The precipitation over the area drained by the Souris is very small, being from 15 to 18 inches, and the actual run-off for the year ending October 31, 1913, was found to be 1·4 inches per square mile of drainage area.

This extremely small run-off from the large area drained may be attributed to: First, small rainfall and snowfall; second the topography of the country; the flat prairie country through which the river runs holds the water in the sloughs where it evaporates rapidly, aided by the winds which have full play across the open stretches; third, the distribution of the rainfall. It is noticed from meteorological reports that the greatest amount of rainfall in this area comes in the growing season of the year, when evaporation losses are also greatest.

(*b*) *Discharge Measurements.*—In October of the year 1912, a metering station was established on the river at the town of Wawanesa, by the Manitoba Hydrographic Survey, and during the winter of 1912-13, and the spring and summer of the present year, eight discharge measurements have been made, the results of which are shown in table No. 43.

Daily gauge height records have been kept at this station and these with their estimated discharges are shown in tables No. 44 and No. 45.

G.—WATER-POWER.

The difference in elevation between the water levels where the river joins the Assiniboine and the point where it first enters the province is 305 feet, or about 2 feet per mile.

There has been no survey work done on this river for the purpose of locating possible power sites, and the estimate of power obtainable as shown in table below is per foot of head.

This table is based on the estimated minimum flow for the year ending October 31, 1913, and also on the lowest mean monthly flow for a period of six months from May to October of the same year. These figures apply only to the periods above stated.

Head in feet.	Estimated horse-power at 80 per cent efficiency.	
	Minimum flow 5 sec.-ft.	Flow 50 sec.-ft. Period May to October.
1	·45	4·5
10	4·5	45
20	9	90

TABLE No. 43.

DISCHARGE MEASUREMENTS of Souris River, near Wawanesa, 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean Velocity.	Gauge height.	Discharge.
1912			Feet.	Sq. ft.	Ft. per sec	Feet.	Sec.-ft.
Oct. 7	W. G. Worden	1496	85·0	169·2	·53	1·50	89·6
Oct. 26	G. Lamb	1186	86·0	162·3	·55	1·49	89·3
1913.							
Jan. 29	G. Lamb	1374	21·5	19·5	·38	1·93	7·5
Apr. 15	E. Bankson	1469	94·2	436·8	2·51	4·25	1087·7
May 7	E. Bankson	1469	96·2	462·8	3·01	4·82	1431·1
June 30	A. Pirie	1496	86·0	156·4	·56	1·49	89·0
Aug. 11	W. J. Ireland	1469	85·0	129·3	·32	1·20	41·6
Sept. 10	W. J. Ireland	1469	85·0	131·0	·35	1·27	46·1

(1) Ice measurements.

TABLE No. 44.

DAILY GAUGE HEIGHT AND DISCHARGE, Souris River, near Wawanesa, for 1912.

Day.	October. Gauge height.	October. Discharge.	November. Gauge height.	November. Discharge.	Day.	October. Gauge height.	October. Discharge.	November. Gauge height.	November. Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.		Feet.	Sec.-ft.	Feet.	Sec.-ft.
1			1·44	77	17	·50	84	·61	
2			·53	88	18	·49	83	·50	
3			·50	84	19	·51	85	·56	
4			·56	92	20	·49	82	·54	
5			·44	77	21	1·48	82	1·52	
6			1·40	72	22	·49	83	·64	
7	1·50	84	·41	73	23	·48	82	·45	
8	·50	84	·42	74	24	·46	79	·62	
9	·52	87	·39	71	25	·49	83	·36	
10	·52	87	·43	76	26	1·49	83	1·66	
11	1·50	84	1·45	78	27	·47	80	·55	
12	·50	84	·45	78	28	·47	80	·63	
13	·50	84	·43	76	29	·48	82	·63	
14	·51	85	·42	74	30	·49	83	·63	
15	·53	88	·41	73	31	·46	79		
16	1·49	83	1·77						

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE,

Day.	January.		February.		March.		April.		May.	
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1			1·97		2·08				4·89	1,435
2									·90	1,440
3									·91	1,445
4	1·81								·86	1,420
5									·83	1,405
6									4·83	1,405
7									·82	1,400
8			1·63		2·08				·80	1,390
9									·78	1,380
10									·73	1,355
11	1·62								4·67	1,325
12									·59	1,285
13									·52	1,250
14									·43	1,205
15			1·50		3·22		4·24	1,110	·29	1,135
16							4·24	1,110	4·06	1,020
17							·35	1,165	3·85	915
18	2·07						·48	1,230	·66	820
19							·61	1,295	·48	730
20							67	1,325	·25	615
21							4·74	1,360	3·05	515
22			2·23		3·61		·78	1,380	2·94	463
23							·83	1,405	·86	429
24							84	1,410	·81	409
25							·87	1,425	·75	385
26							4·87	1,425	2·69	361
27							·86	1,420	·59	327
28							·83	1,405	·59	327
29	1·93	7·5			3·33		·83	1,405	·54	312
30							·83	1,405	45	285
31									·38	264

No. 45.

Souris River, near Wawanesa, for 1913.

June.		July.		August.		September.		October.		
Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Day.
Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	
2·29	237	....	78	1·19	47	1·24	53	1·25	54	1
22	220	1·42	74	·19	47	·22	50	·25	54	2
·18	210	·41	73	18	46	·24	53	·26	55	3
·07	183	·40	72	·18	46	·25	54	·25	54	4
·17	207	·38	67	·17	45	·25	54	·20	48	5
2·12	195	1·34	65	1·17	45	1·28	57	1·18	46	6
·02	172	·34	65	·19	47	·27	56	·17	45	7
1·99	166	·30	60	·17	45	·27	56	·20	48	8
·96	160	·29	59	·17	45	·24	53	·21	49	9
·94	156	·30	60	·19	47	·27	56	·28	57	10
1·87	142	1 34	65	1·20	48	1·27	56	1·27	56	11
·85	139	·36	67	·20	48	·28	57	·27	56	12
·82	133	·37	68	·20	48	·27	56	·30	60	13
·82	133	·40	72	·20	48	·25	54	·28	57	14
·82	133	·35	66	·26	55	·25	54	·25	54	15
1·81	132	1·35	66	1·19	47	1·25	54	1·22	50	16
·75	122	·34	65	·27	56	·26	54	·26	55	17
·69	112	·29	59	·26	55	·26	55	·24	53	18
·68	110	·27	56	·33	64	·28	57	·23	52	19
63	102	·25	54	·26	55	31	61	22	50	20
1·57	93	1·24	53	1·38	70	1·27	56	1·15	43	21
50	84	·23	52	·38	70	·22	50	·20	48	22
·49	83	·22	50	·35	66	·27	56	·22	50	23
·48	82	·21	49	·35	66	·32	62	·23	52	24
·44	77	·22	50	·34	65	·31	61	·24	53	25
1·41	73	1·20	48	1·34	65	1·22	50	1·22	50	26
·41	73	·19	47	·33	64	·28	57	·23	52	27
·55	91	·18	46	·29	53	·26	55	·15	43	28
·55	91	·18	46	·26	55	·26	55	·18	39	29
·49	83	·18	46	·26	55	·26	55	·18	39	30
....	....	·18	46	·26	55	....	....	·19	39	31

Shell River.

A.—Location.

The Shell river, one of the largest tributaries of the Assiniboine, has its source in the northerly part of Duck mountain, and flowing from the same, empties into the Assiniboine about three miles above the village of Shellmouth.

B.—Direction.

The general direction of the river is almost due south from its source; crossing and re-crossing the dividing line between ranges 27 and 28 west of the first meridian to a point within five miles of its mouth, where it bends sharply to the west and joins the Assiniboine from a southeasterly direction.

C.—River Basin.

The watershed near the mouth of the river is narrow, being confined between the watersheds of the Valley river and the Assiniboine; but as it nears the upper reaches, it broadens out to approximately 35 miles in width, where it adjoins the watershed of the Swan river. It is in this upper section that most of its drainage is obtained, though throughout the entire length of the river it is continually fed by springs and short streams, common in the river flowing in so well-defined a valley, of a gravelly

formation, as that of the Shell. The largest tributary entering the river is met with about 70 miles from its mouth, and is known as the East Branch Shell river.

The length of the basin from north to south is approximately 60 miles, while the river itself, taking into account its widenings, has a length of 90 miles.

D.—NATURE OF BANKS.

The valley of the Shell is one of the most beautiful to be met with in connection with any of the smaller rivers of the province, varying in depth from 100 feet, near the head-waters, to 350 feet, when within about four miles of its mouth, and with an average width of three-quarters of a mile.

The banks are mostly of a gravelly nature, strewn with boulders and overgrown with scrub and small poplar. While on the plateaus on either side is to be found agricultural land which will compare very favourably with the best to be found in the province.

E.—WIDTH OF RIVER AND NATURE OF BOTTOM.

The natural bed of the river varies between 50 and 90 feet in width, and is stated as being of a gravelly nature throughout, and strewn with large boulders.

Throughout the length of the river there are to be found no distinct falls, but numerous rapids are met with where the valley has narrowed and the bed of the river is contracted.

F.—TIMBER AND VEGETATION.

The upper waters of the river flow through the Duck Mountain Forest reserve, and in this district valuable timber is to be found. As the course is followed southward, it is stated that the timber has been burnt over and scrub and light poplar covers the unbroken land, while low in the valley there is considerable spruce and tamarack.

On reaching the flats at the junction of the Shell and Assiniboine, some splendid groves of large elms are encountered.

For some years a small saw-mill was operated at the village of Asessipi, but for the last fifteen years no lumbering operations have been carried on, on this river.

G.—HIGH AND LOW WATER.

At the point where observations for high and low water are made, it was found that there is a variation of about four feet between high water, which usually occurs during the months of May and June, and low water, as a rule during the month of September. It was learned from local inquiry that the river is not subject to sudden changes or to excessive floods, its rise and fall being mostly steady and gradual.

H.—TRANSPORTATION.

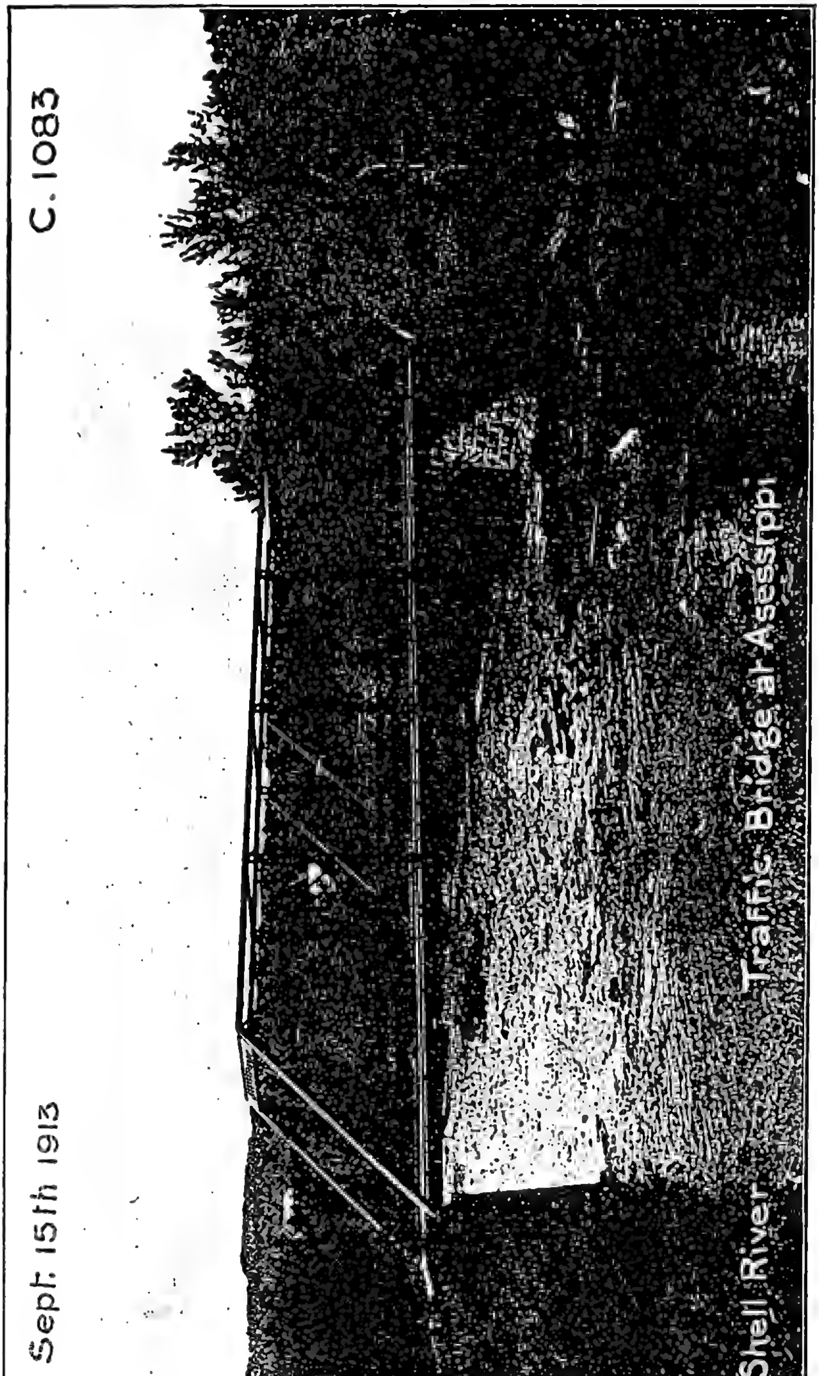
On account of the depth and the numerous rapids, the only means of navigating the river itself would be by canoe. There are various points in its length where it is crossed by trails and, for a considerable distance in the middle length of the river, trails follow closely the course of same.

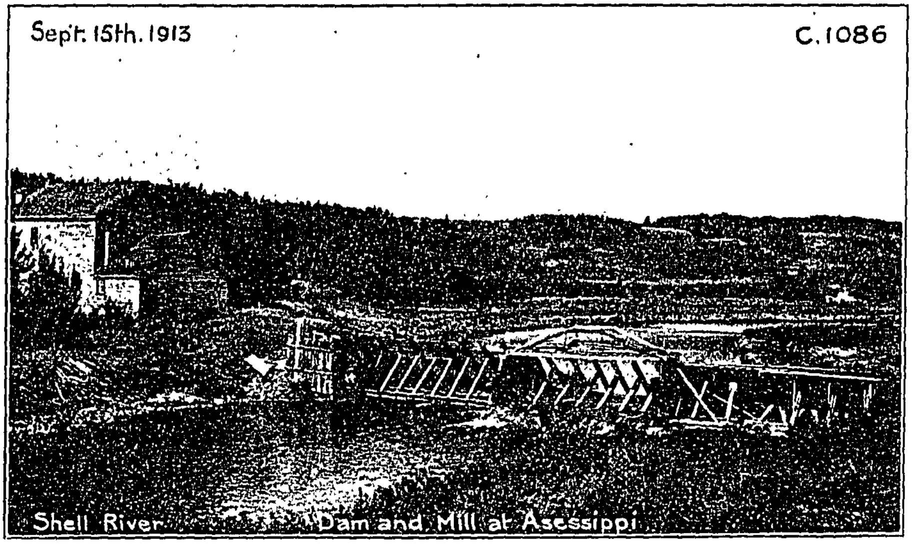
The C. N. R., Edmonton branch crosses the river at the town of Shevlin, while the closest railroad station in the vicinity of the mouth of the river is on the C.N.R. at Shellmouth.

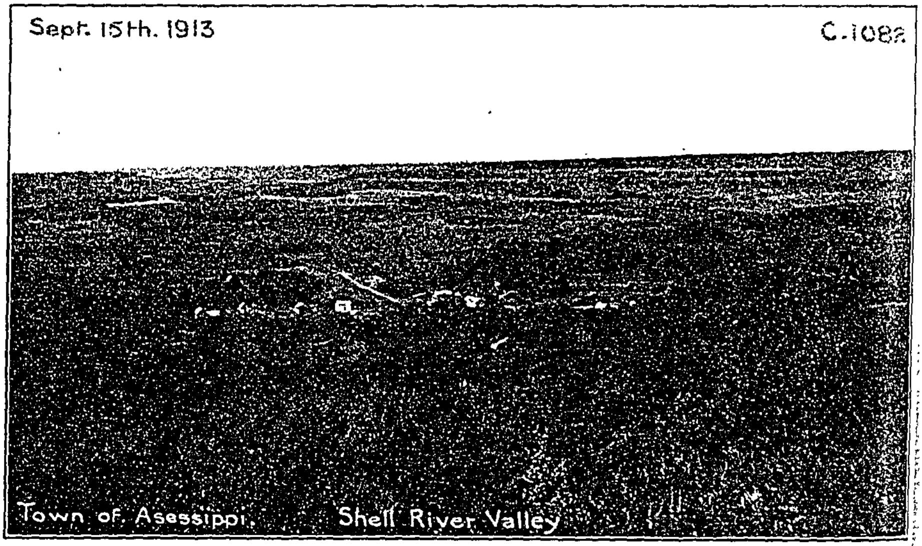
I.—SETTLEMENTS.

Although in the southerly section of the river basin the land is well settled, there are only two small villages on the river itself, one at Asessipi, about four miles from the mouth, and the other at Shevlin, twenty-five miles upstream.

The village of Asessipi is comprised of possibly fifty people, there being located there a store, a school, a church and an old flour and grist mill. This mill has been operated by water power from the year 1884 up to the spring of 1911, when it was put


Sept. 15th 1913
C. 1083
Shell River Traffic Bridge at Assessippi


Sept. 15th. 1913
C.1086
Shell River
Dam and Mill at Asessippi


Sept. 15th. 1913
Town of Asessippi.
Shell River Valley

out of commission through the breaking away of the dam from which it obtained its power. The dam is at present being repaired, and it is expected that it will be in operation during the coming winter.

The town of Russell is located fourteen miles directly south of Asessipi, and a splendid well-settled farming country lies between the two.

J.—RUN-OFF.

(*a*) *Rainfall.*—The precipitation records covering a period of nine years, taken at Russell, located at the south of the drainage area of the river, give a mean yearly rainfall of 16·4 inches. Records taken at Swan river at the north of the drainage area and covering a period of four years, give a mean yearly rainfall of 20·8 inches. The above records would give approximately a mean yearly precipitation for the river basin of 18 inches. Assuming 25 per cent of this as actual run-off, we have a mean yearly discharge of 288 second-feet, or 0·33 second-feet per square mile of drainage area.

(*b*) *Discharge measurements.*—A regular gauging station was established on the river during November of the present year, by the Manitoba Hydrographic Survey. Field work in connection with this station is being carried on, but as yet sufficient data have not been collected on which to base a definite estimate of flow.

The result of a discharge measurement made by this survey, September 15, 1913, will be found in table No. 46. This measurement was made when, acording to local authority, the stage of the river approached very nearly the ordinary low-water level for the year.

K.—WATER-POWER POSSIBILITIES.

As to the locations for possible power developments, there is very slight information, there having been no survey work done on the river with this object in view, but from casual observance and the information at hand, it seems as if this river is to be rated as one of the best for power purposes among the smaller rivers of the province.

From the mouth of the river to the junction of the East Branch Shell river, approximately 75 miles, there is a difference in elevation of 600 feet, or 8 feet to the mile. This fall is quite evenly distributed in the upper reaches, but the percentage of drop increases in the lower section of the river. This natural drop, combined with the accompanying high banks, practically throughout the course of the river, point to easy development at different points along its course.

The one development on the river at Asessipi has a head of 10 feet, and though using only a small portion of the flow, developed 50 horse-power, and never at any time of the year was there experienced trouble through lack of flow.

There having been no survey made on the river locating possible dam sites, the information as to actual head at any such is not available, but the following table gives the possible horse-power per foot head, with an assumed minimum monthly flow. This assumed flow is taken as extending over a period of six months, from May to October, and is subject to revision.

In the table (*a*) is the head in feet, (*b*) is the assumed minimum flow in second-feet during the six open months of the year, (*c*) is the available horse-power at 80 per cent efficiency.

(*a*)	(*b*)	(*c*)
1	200	18·2
10	200	182·0
20	200	364·0

In regard to winter flow on the river, sufficient data are not at hand on which to base an estimate, as there have been no winter observations made, but the above figures for the open months would possibly be reduced 60 per cent during the remaining six months of the year.

TABLE No. 46.

DISCHARGE MEASUREMENTS of Shell River at Asessipi, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of sections.	Mean velocity.	Gauge height.	Discharge
1913.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Sept. 15 ...	W. J. Ireland...	1469	83·0	93	2·3	No gauge.	213·5

THE ASSINIBOINE RIVER.

The Assiniboine river has its source in the province of Saskatchewan in the south-easterly slopes of Nut mountain adjacent to the head-waters of the Red Deer river. From here the river flows in a southwesterly direction until it crosses the boundary between Saskatchewan and Manitoba, where it bends southward and follows this direction until approximately in the latitude of Brandon where it assumes an easterly bearing, and this general direction is followed to a point where it joins the Red river in the city of Winnipeg.

B.—RIVER BASIN.

The total drainage basin of the Assiniboine covers an area of 59,550 square miles. Of this area approximately 8,800 square miles lie in the state of North Dakota, 37,-700 miles in the province of Saskatchewan, and 13,050 miles in the province of Manitoba.

The principal tributaries of the river are the Quapelle, the Souris, the Shell, and the Little Saskatchewan.

The drainage entering the river in the lower hundred miles of its course is very slight, as the basin is confined between the watersheds of the Red river and lake Manitoba.

Above the city of Brandon a large increase of the incoming drainage is noticed, and in its upper course the river is continually fed by springs, and streams draining the numerous small lakes with which the upper basin is dotted.

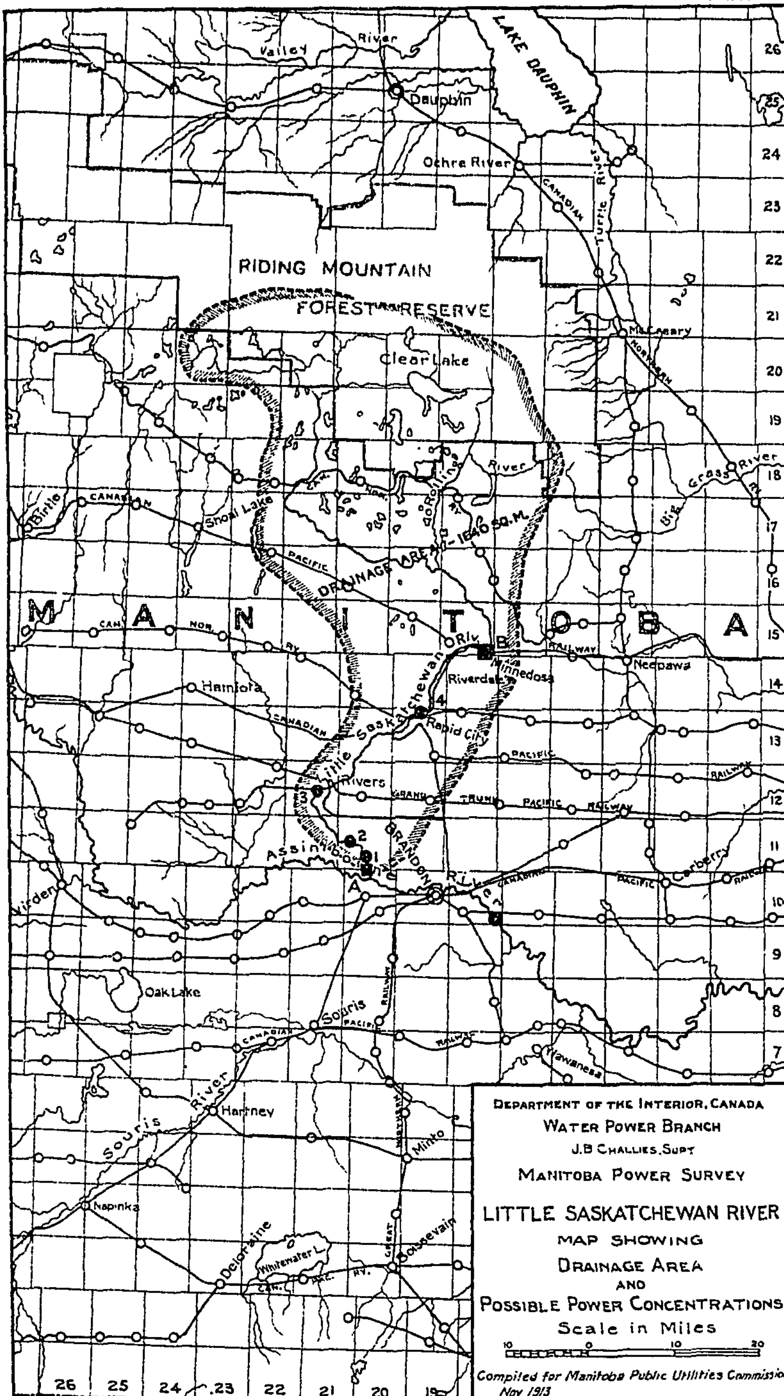
C.—DESCRIPTION OF BANKS.

At the point where the river crosses the dividing line between Manitoba and Saskatchewan, the river flows in a narrow valley, with the banks rising sharply to a height of two hundred and fifty feet on the east side, and with a more gradual rise on the west to approximately the same elevation.

The high banks of the valley seem to be characteristic of the river until it has reached a point considerably below the junction of the Souris river. From this point to the mouth the river flows through level prairie land, with sharply cut banks rising directly from the water's edge to a height varying from three or four feet to twenty-five feet.

There is noted a great variation in the width of the valley, which, in a number of districts, spreads sufficiently to allow the carrying on of extensive farming operations on the flats which lie on either side of the river. The soil of these flats, though being of a very rich nature, is in constant danger of flood in the spring freshets.

PLATE 12



Douglas L. McLean Chief Engineer
Stuart S. Scovil Asst. Chief Engineer

D.—WIDTH AND BED OF RIVER.

The approximate width of the river where it enters the province is one hundred and fifty feet, and in its course it varies between this width and two hundred and fifty feet.

The bed of the river in the upper reaches is mostly of a sandy or gravelly nature, mixed with large boulders, but as it nears the outlet the banks and bed are composed largely of a sandy clay and boulders, with an underlying stratum of blue clay at a depth of from five to ten feet.

E.—TIMBER AND VEGETATION.

Throughout the basin of the river in Manitoba the land is practically all settled and being worked for agricultural purposes. There is very little standing timber of any value to be found on same. What is met with is mostly small and of little value except for firewood.

F.—SETTLEMENTS.

Th Assiniboine flows through the mostly thickly-settled section of the province and on its banks are found three of the largest cities in the province, namely, Winnipeg, Portage La Prairie and Brandon, while its point of junction with the Red river is directly opposite the city of St. Boniface.

G.—TRANSPORTATION AND ACCESSIBILITY.

In the lower reaches the river can be navigated with boats of small draft but, on account of its very winding nature and the numerous shoals, the river is not used for navigation of a commercial nature or for purposes other than pleasure. At almost any point in its length in Manitoba the river is easily accessible from good roads and prairie trails. It is crossed by numerous lines of railroads, and its course is closely paralelled by them for a large percentage of its length throughout the province.

II.—RUN-OFF.

(a) *Rainfall.*—From the records of the metereological stations scattered throughout the basin of the river, we find that the average annual precipitation for the drainage area is approximately seventeen inches.

(b) *Discharge measurements.*—A gauging station was established on the river at the St. James C.P.R. bridge in May of the year 1912, by the Manitoba Hydrographic Survey. At this station sixteen discharge measurements were taken during a year's observations. The results of these measurements are shown in table No. 55. This station was abandoned in the spring of the present year to escape the possibility of backwater effects from the closing of the dam at the St. Andrew's locks. There are at present three gauging stations located on the river, which were established by the Manitoba Hydrographic Survey. The first of these, established in the spring of 1913, is located at the C.P.R. bridge at Headingly, fourteen miles west of the city of Winnipeg. Since the installation of this station there have been fourteen discharge measurements made, the result of which are shown in table No. 53. Daily gauge readings have also been made and a record of these, with the estimated daily discharges, will be found in table No. 54.

The second station is located in the city of Brandon at the First street traffic bridge. It was established in July of 1912, and since that time continuous observations have been carried on. A record of the discharge measurements made during that time will be found on tables No. 49 and No. 50, and the daily gauge heights with their estimated daily discharges are recorded in tables No. 51 and No. 52.

The third station, located at the village of Millwood, was established in October of 1912, on the traffic bridge below the old dam and, during the year, eight discharge measurements were taken, the results of which are shown in table No. 47. The daily gauge height records, with estimated daily discharges, are given in table No. 48.

I.—HIGH AND LOW FLOW.

The river, during the spring freshets, is liable to large variations in stage, and during the present year a variation of twelve feet has been noted between the extreme high and low-water level. The period of high water, however, does not cover more than three weeks, and the average variation during the remainder of the year is approximately five feet.

J.—POWER DEVELOPMENTS.

There are at present no power developments on the river in the province of Manitoba, the one previous development having been destroyed in the spring flood of this year. This development was located at the village of Millwood, where a total head of eighteen feet was obtained. The power developed was for the purpose of operating a flour mill, but it has not been used to any great extent in late years. A timber dam was built across the river, and a large part of this still remains in fairly good condition, but the foundations of the mill itself were destroyed by the scouring action of the water and, the building being mostly of timber construction, was carried down the river. Photographs of this location in its present condition are shown on page 113.

K.—POWER SURVEYS.

There have been three surveys made on the river in the vicinity of the city of Brandon with a view of locating possible dam sites for the development of power for the city, one of these being made in 1902 by the late Cecil B. Smith for the Western Electric Light and Power Company. The second, by R. E. Speakman, city engineer of the city of Brandon. This survey was made at the instance of Mr. Speakman for the purpose of investigating a proposition made to the city by the above-mentioned power company. During the early summer of the present year a reconnaissance survey was made by the Manitoba Power Survey under the direction of the late G. H. Burnham, at a point about twelve miles below Brandon.

The results of these surveys show that in the vicinity of Currie's Landing (see plate No. 13), twelve miles below the city of Brandon, there is a possible head of eighteen feet obtainable. This head would probably be diminished somewhat during times of high water.

L.—WATER-POWER.

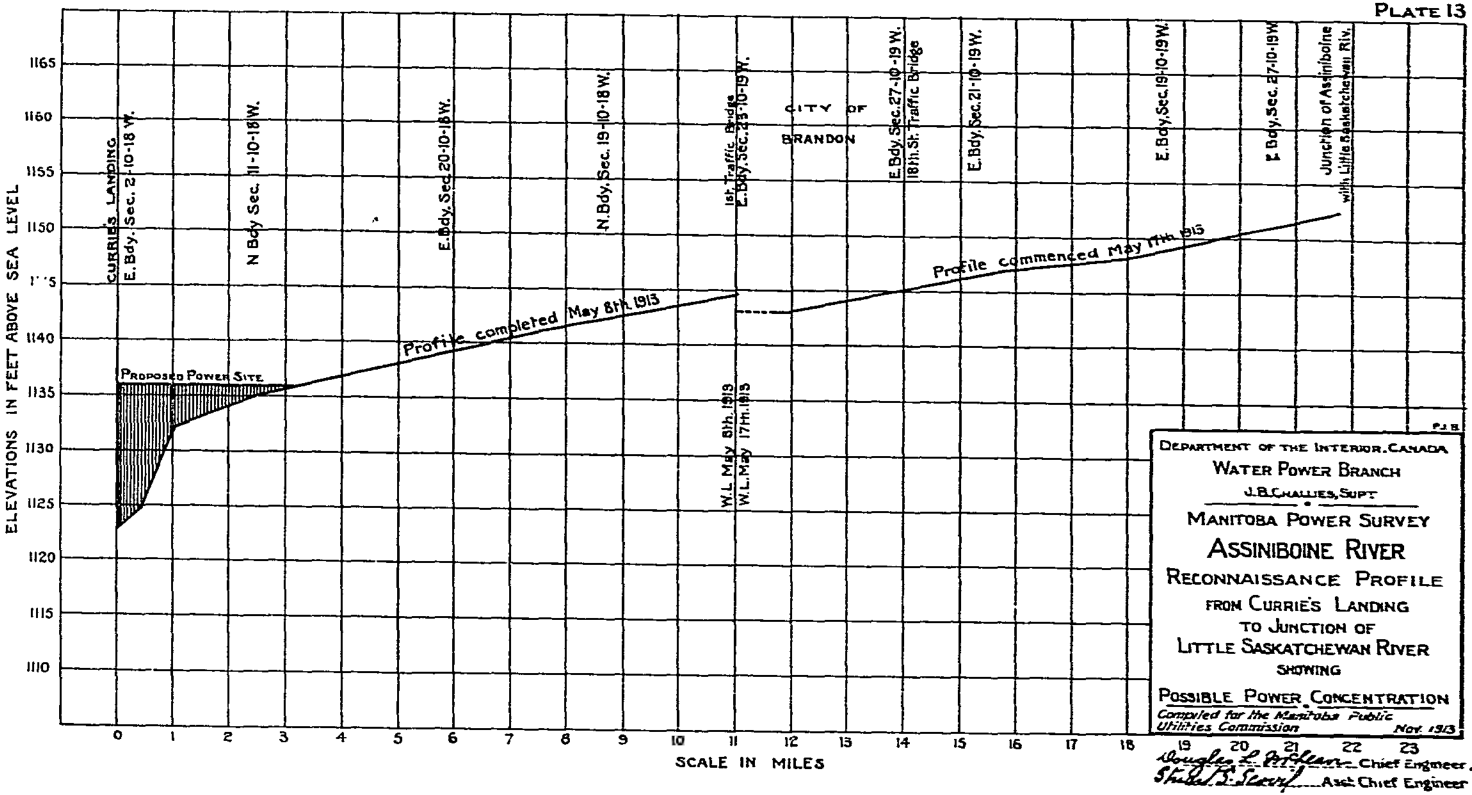
Based on the estimated flow at the three metering stations above noted, for the year ending October 31, 1913, the following tables give the power available per feet at an 80 per cent efficiency, and for the estimated low flow at each station, and also for the lowest monthly mean flow for a period of six months, from May to October. In this latter case the estimated power only relates to the period as stated above.

These tables would apply to any proposed development on the river in the neighbourhood of the stations at which the information was obtained, and also at the Currie's Landing dam site.

HEADINGLY.

Head in feet.	Estimated Horse-power at 80 per cent Efficiency.	
	Minimum flow 400 sec.-ft.	Flow 1182 sec.-ft. Period May to Oct.
1	36·3	107·5
10	363	1075
20	726	2150

Plate 13


Curries Landing
E. Bdy. Sec. 2-10-18 W.
N Bdy Sec. 11-10-18 W.
E. Bdy. Sec. 20-10-18 W.
N. Bdy. Sec. 19-10-18 W.
1st. Traffic Bridge
E. Bdy. Sec. 23-10-19 W.
City of Brandon
E. Bdy. Sec. 27-10-19 W.
18th. St. Traffic Bridge
E. Bdy. Sec. 21-10-19 W.
E. Bdy. Sec. 19-10-19 W.
E Bdy. Sec. 27-10-19 W.
Junction of Assiniboine with Little Saskatchewan Riv.
Proposed Power Site
Profile completed May 8th 1913
Profile commenced May 17th 1913
W. L. May 8th 1913
W. L. May 17th 1913
Elevations in feet above sea level
1165
1160
1155
1150
1145
1140
1135
1130
1125
1120
1115
1110
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Scale in miles
P.J.B.
Department of the Interior, Canada
Water Power Branch
J. B. Challies, Supt.
Manitoba Power Survey
Assiniboine River
Reconnaissance Profile
from Currie's Landing
to Junction of
Little Saskatchewan River
showing
Possible Power Concentration
Compiled for the Manitoba Public Utilities Commission
Nov. 1913
Douglas L. McLean Chief Engineer.
Stuart B. Sears Asst. Chief Engineer

BRANDON.

Head in feet.	Estimated Horse-power at 80 per cent Efficiency.	
	Minimum flow 400 sec.-ft.	Flow 1030 sec.-ft. Period May to Oct.
1	36·3	93·6
10	363	936
20	726	1872

MILLWOOD.

Head in feet.	Estimated Horse-power at 80 per cent Efficiency.	
	Minimum flow 160 sec.-ft.	Flow 705 sec.-ft. Period May to Oct.
1	14·5	64·0
10	145	640
20	290	1280

CURRIE'S LANDING DAM SITE.

Head in feet.	Estimated Horse-power at 80 per cent Efficiency.	
	Minimum flow 400 sec.-ft.	Flow 1030 sec.-ft. Period May to Oct.
18	653	1685

TABLE No. 47.

DISCHARGE MEASUREMENTS of Assiniboine River, near Millwood, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
1912.							
Oct. 11	Worden	1497	145	881·2	1·85	2·29	1628
1913.							
Jan. 27	G. Lamb	1374	146	251·4	0·68	·48	174[1]
April 19	E. Bankson	1469	157·5	1484·4	3·08	6·45	4571
May 9	" "	1469	192	1704·8	3·08	7·42	5253
July 3	A. Pirie	1496	145	740	1·82	1·65	1346
Aug. 6	W. J. Ireland	1469	168·8	1469·8	2·58	5·65	3789
Sept. 13	" " "	1469	144	699·7	1·72	1·30	1201
Oct. 19	C. O. Allen	1435	144·5	536·5	0·31	0·31	632

(1) Ice measurement.

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE of

Day.	January.		February.		March.		April.		May.	
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	...	...	...	...	...	...	...	...	...	6,351
2	...	...	0·40	...	0·80	...	...	...	8·25	6,183
3	...	...	...	...	...	...	...	...	7·80	5,720
4	...	...	...	...	...	...	...	...	8·20	6,130
5	...	...	...	...	...	...	...	...	7·70	5,625
6	...	...	...	...	...	...	1·50	1,260	7·50	5,435
7	...	...	...	...	...	...	...	...	7·20	5,150
8	...	...	...	...	...	...	...	...	6·80	4,780
9	...	...	0·20	...	0·80	...	...	...	7·40	5,340
10	...	...	...	...	...	...	...	...	7·20	5,150
11	...	...	...	...	...	...	...	...	7·10	5,055
12	...	...	...	...	...	...	...	...	7·00	4,960
13	...	...	...	...	...	...	7·50	5,435	6·80	4,780
14	...	...	...	...	...	...	6·83	4,807	·60	4,600
15	...	...	...	...	...	...	·50	4,515	·50	4,515
16	...	...	0·10	...	0·90	...	6·50	4,515	6·40	4,430
17	...	...	...	...	...	...	·58	4,583	·20	4,270
18	...	...	...	...	...	...	·42	4,147	·00	4,110
19	...	...	...	...	...	...	·50	4,515	5·90	4,035
20	...	...	...	...	...	...	·83	4,807	·80	3,960
21	...	...	...	...	...	...	7·83	5,748	5·70	3,885
22	...	...	...	...	...	...	...	...	·60	3,810
23	...	...	0·30	...	0·80	...	...	...	·50	3,735
24	...	...	...	...	...	...	...	...	·40	3,660
25	...	...	...	...	...	...	...	...	·40	3,660
26	0·48	...	...	...	...	...	...	...	5·30	3,558
27	...	...	...	...	...	...	...	...	·20	3,515
28	...	...	...	...	...	...	...	...	·20	3,515
29	...	...	...	...	...	...	...	...	·10	3,445
30	...	...	...	...	1·00	...	...	...	·00	3,375
31	...	...	...	...	...	...	...	...	·90	3,305

No. 48.

Assiniboine River, near Traffic Bridge, Millwood, for 1913.

June.		July.		August.		September.		October.		
Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Day.
Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	
4·80	3,235	1·40	1,210	5·60	3,810	2·17	1,609	0·31	746	1
·70	3,165	·50	1,260	·65	3,848	·07	1,551	·31	731	2
·50	3,035	·68	1,350	·70	3,885	·00	1,515	·29	726	3
·40	2,970	2·40	1,735	·70	3,885	1·96	1,493	·26	706	4
·40	2,970	3·00	2,085	·73	3,908	93	1,477	·23	702	5
4·20	2,840	3·80	2,580	5·70	3,885	1 87	1,415	0·20	690	6
·00	2,710	4·30	2,905	·60	3,810	·79	1,405	·19	686	7
3·70	2,515	·55	3,068	·50	3,735	·73	1,375	·18	682	8
40	2,325	·68	3,152	·20	3,515	·66	1,340	·18	682	9
20	2,205	·80	3,235	4·70	3,165	·55	1,285	·23	702	10
3·00	2,085	5·00	3,375	4·00	2,710	1·46	1,240	0·26	714	11
2·70	1,905	·57	3,788	3·40	2,325	·36	1,190	·29	726	12
·70	1,905	·65	3,848	05	2,115	·26	1,142	·29	726	13
·50	1,790	·80	3,960	2·70	1,905	·18	1,106	·29	726	14
·20	1,625	·83	3,983	·40	1,735	·10	1,070	·30	730	15
2·10	1,570	5·88	4,020	2 40	1,735	1·01	1,030	0·30	730	16
·00	1,515	·92	4,050	....	1,780	0·91	985	·32	738	17
1·90	1,460	·90	4,035	....	1,840	·85	958	32	738	18
·70	1,360	·85	3,998	....	1,890	·80	935	·30	730	19
·60	1,310	·88	4,020	....	1,940	·73	904	·28	722	20
1 50	1,260	5·90	4,035	....	2,000	·68	853	0 29	726	21
·40	1,210	·95	4,073	2 86	2,001	0·61	854	·11	666	22
·30	1,160	·93	4,058	·94	2,049	·56	834	·70	890	23
30	1,160	·85	3,998	·99	2,079	·54	826	12	658	24
·20	1,115	·80	3,960	·92	2,037	·50	810	25	710	25
1·10	1,070	5·75	3,923	2·79	1,959	0·49	806	0 29	726	26
00	1,025	·70	3,885	2·77	1,947	·46	794	·20	690	27
·00	1,025	·60	3,810	·67	1,887	·42	778	·04	595	28
10	1,070	·60	3,810	·51	1,796	·40	770	·23	535	29
30	1,160	·60	3,810	·39	1,730	·37	758	·18	682	30
......	....	·60	3,810	26	1,658	....	....	·05	632	31

TABLE No. 49.

DISCHARGE MEASUREMENTS of Assiniboine River, at Brandon, 1912.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
July 4	G. H. Burnham	1187	216·5	985·7	2·74	3·79	2701
July 6	"	1187	214·5	889·3	2·72	3·53	2419
July 20	"	1187	216	870·2	2·72	3·31	2367
July 22	"	1187	215·5	857·2	2·62	3·15	2246
Aug. 10	W. G. Worden	1187	207·1	791·1	2·59	2·99	2049
Aug. 23	A. Pirie	1197	190·5	738·0	2·03	2·19	1489
Oct. 5	W. G. Worden	1497	233·5	1504·5	3·16	6·28	4745
Oct. 25	G. Lamb	1187	215·5	950·5	2·77	3·87	2633

TABLE No. 50.

DISCHARGE MEASUREMENTS of Assiniboine River, at Brandon, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Jan. 22	G. Lamb	1375	148	238·5	1·62	1·95	387(1)
Feb. 20	A. Pirie	1469	167	277·0	1·37	1·95	380(1)
April 7	E. Bankson	1469	262	2099·7	3·77	8·54	7578
May 6	"	1469	348	3327·6	3·87	12·37	12869
June 28	A. Pirie	1496	205	826·6	2·48	3·21	2048
Aug. 9	W. J. Ireland	1469	243·1	1516·7	2·93	5·69	4442
Sept. 9	"	1469	214·2	756·9	2·41	2·77	1833
Oct. 20	"	1469	183·3	505·8	1·74	1·47	880

(1) Ice measurement.

TABLE No. 51.

DAILY GAUGE HEIGHT AND DISCHARGE, Assiniboine River, near Brandon, for 1912.

Day.	July.		August.		September.		October.		November.	
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft
1	....	....	3·03	2046	2·21	1472	6·58	5223	3·46	2365
2	....	....	3·08	2081	2·26	1507	6·52	5157	3·40	2320
3	....	....	3·07	2074	2·30	1535	6·47	5102	3·32	2360
4	3·65	2510	2·99	2018	2·27	1514	6·35	4970	3·25	2208
5	3·55	2433	3·05	2060	2·29	1528	6·26	4873	3·21	2178
6	3·48	2380	3 08	2081	2·32	1549	6·19	4800	3·18	2155
7	3·01	2032	3·00	2025	2·48	1661	5·95	4548	3·15	2133
8	3·09	2088	2·91	1962	2·77	1864	5·82	4415	3·12	2110
9	2·71	1822	3·00	2025	2·95	1990	5 68	4275	3·08	2081
10	2·76	1857	2·98	2011	3·21	2178	5·50	4100	3·05	2060
11	2·83	1906	2·91	1962	3·40	2320	5·33	3939	3·02	2039
12	2·89	1948	2·91	1962	3·72	2566	5·13	3757	3·00	2025
13	2 87	1934	2 91	1962	3·93	2734	4·95	3595	2·96	1997
14	2·81	1892	2·79	1878	4 60	3290	4·80	3460	2·92	1969
15	2·92	1969	2·53	1696	4 73	3401	4·67	3350	2·89	1948
16	3·03	2046	2 59	1738	4·78	3443	4 55	3248	2·87	1934
17	3·22	2185	2·42	1619	4 80	3460	4·43	3146	2·40	1605
18	3·40	2320	2·31	1542	4 78	3443	4·35	3078	2·40	1605
19	3·13	2118	2·30	1535	4·79	3452	4·27	3010	2·40	1605
20	3·13	2118	2·33	1556	4·79	3452	4·18	2954	2·39	1598
21	3·20	2170	2 23	1486	4·97	3613	4·10	2870	2·39	1598
22	3·14	2125	2·15	1433	5·46	4062	3·98	2774	2·26	1507
23	3·04	2053	2·10	1400	5·51	4110	3 92	2726	2·14	1426
24	2·95	1990	2·05	1368	5·59	4186	3·88	2694	2·14	1426
25	2·90	1955	2·23	1486	5·68	4275	3·87	2686	2·60	1745
26	2·71	1822	2·03	1355	5·71	4305	3·80	2630		
27	2·90	1955	2·00	1335	5·89	4485	3·73	2574		
28	2·81	1892	1·90	1270	6 00	4600	3 68	2534		
29	3 02	2039	2·20	1465	6·27	4884	3·62	2486		
30	3·01	2032	1·93	1290	6·44	5069	3·57	2448		
31	2·99	2018	1·97	1316	....	....	3·53	2410		

TABLE No. 52.

Daily Gauge Height and Discharge, Assiniboine River, at Brandon, 1913.

Day.	April.		May.		June.		July.		August.		September.		October.	
	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	......	......	13·82	14837	6·65	5303	3·20	2140	5·95	4548	3·43	2343	1·62	1088
2	......	......	13·82	14837	6·57	5212	3·11	2103	5·90	4495	3·30	2245	1·58	1062
3	......	......	......	......	6·40	5025	3·13	2118	5·86	4455	3·22	2185	1·55	1043
4	......	......	......	......	6·23	4812	3·27	2223	5·85	4445	3·17	2148	1·50	1010
5	......	......	......	......	6·09	4695	3·45	2358	5·85	4445	2·80	1885	1·52	1023
6	......	......	12·37	12880	6·00	4600	3·65	2510	5·84	4435	3·02	2039	1·67	1121
7	......	......	......	......	5·80	4395	3·71	2558	5·83	4425	3·08	2081	1·60	1075
8	......	......	......	......	5·72	4315	4·10	2870	5·80	4395	2·91	1962	1·40	945
9	......	......	......	......	5·66	4255	4·30	3035	5·73	4325	2·78	1871	1·40	945
10	......	......	......	......	5·59	4186	4·82	3478	5·63	4225	2·71	1822	1·46	984
11	5·88	4475	......	......	5·52	4119	4·96	3604	5·55	4148	2·80	1885	1·58	1062
12	6·41	50[illegible]9	......	......	5·38	3986	5·36	3967	5·55	4167	2·76	1857	1·54	1036
13	6·74	5406	......	......	4·96	3601	5·50	4100	5·57	4148	2·71	1822	1·52	1023
14	8·61	7801	......	......	4·80	3460	5·66	4255	5·50	4100	2·56	1717	1·52	1023
15	8·59	7777	......	......	4·72	3392	5·80	4395	5·42	4024	2·42	1619	1·50	1010
16	8·68	7898	......	......	4·60	3290	6·01	4611	5·28	3892	2·29	1528	1·48	997
17	8·52	7682	......	......	4·45	3163	6·10	4705	5·15	3775	2·24	1493	......	1000
18	8·50	7655	......	......	4·33	3061	6·33	4948	5·08	3712	2·17	1446	......	1000
19	8·48	7628	......	......	4·22	2967	6·45	5080	4·62	3307	2·12	1413	......	1000
20	8·48	7628	9·91	9599	3·84	2662	6·50	5135	3·89	2702	2·05	1368	1·50	1010
21	8·56	7736	8·77	8020	3·79	2622	6·55	5190	3·76	2598	1·99	1329	1·49	1004
22	8·61	7801	8·61	7801	3·70	2550	6·60	5245	3·81	2638	1·85	1238	1·50	1010
23	8·66	7871	8·39	7507	3·62	2486	6·58	5223	3·70	2550	1·76	1179	1·60	1675
24	8·83	8101	8·12	7142	3·54	2425	6·53	5168	3·62	2486	1·75	1173	1·65	1108
25	8·86	8141	7·93	6886	3·40	2320	6·50	5135	3·78	2614	1·74	1166	1·61	1082
26	8·99	8317	7·78	66[illegible]9	3·30	2245	6·45	5080	3·88	2694	1·74	1166	......	......
27	......	......	7·63	6494	3·22	2185	6·42	5047	3·65	2510	1·73	1160	......	......
28	......	......	7·21	5963	3·21	2178	6·30	4915	3·60	2470	1·73	1160	......	......
29	......	......	7·01	5722	3·22	2185	6·18	4789	3·62	2486	1·73	1160	......	......
30	......	......	6·79	5464	3·24	2200	6·10	4705	3·56	2440	1·70	1140	......	......
31	......	......	6·82	5498	......	......	6·02	4621	3·50	2395	......	......	......	......

TABLE No. 53.

DISCHARGE MEASUREMENTS of Assiniboine River, at Headingly, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
1913.			Feet.	Sq. Ft.	Ft. per sec.	Feet.	Sec.-ft.
Apr. 16.	G. H. Burnham	1497	317	2543	3·02	6·85	7673
" 22..	E. Bankson	1469	366	2719	3·40	7·70	9258
May 2..	E. Bankson	1469	366	2888	3·58	8·06	10337
" 7..	G. Ebner	1187	395	3516	3·83	9·61	13464
" 12..	G. Ebner	1186	372	3526	3·86	9·78	13610
" 19.	G. Ebner	1186	370	3118	3·35	8·73	10447
June 23..	G. Ebner	1186	260	1587	2·20	4·13	3491
July 19..	A. Pirie	1496	360	1835	2·36	4·89	4335
Aug. 5..	W. J. Ireland	1469	302	1977	2·41	5·02	4759
" 14..	W. J. Ireland	1469	301	1952	2·44	4·83	4526
" 18..	G. Ebner	1196	261	1871	2·32	4·89	4276
Sept. 16..	C. O. Allen	1435	248	1194	1·64	2·80	1959
" 27..	E. Budge	1186	235	1079	1·44	2·32	1551
Oct. 13..	Ireland and Edmondson	1469	238	1007	1·19	1·95	1201

TABLE No. 54.

DAILY GAUGE HEIGHT AND DISCHARGE, Assiniboine River, at C.P.R. Bridge, Headingly, for 1913.

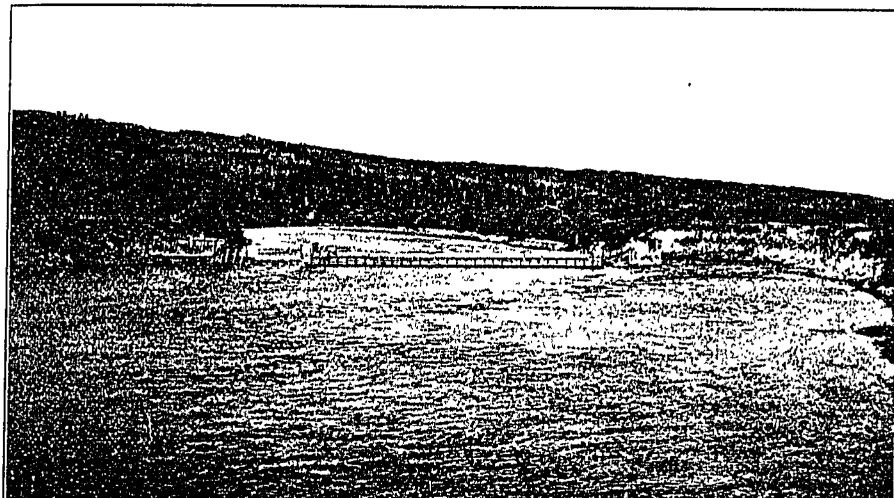
Day.	April.		May.		June.		July.		August.		September.		October.	
	Gauge Height	Discharge	Gauge Height.	Discharge	Gauge Height.	Discharge	Gauge Height	Discharge	Gauge Height.	Discharge.	Gauge Height.	Discharge.	Gauge Height.	Discharge
	Feet.	Sec. ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	8·0	9885	6·35	6768	3·9	3080	5·3	5035	3·5	2640	2·08	1390
2	....	....	8·5	10905	6·28	6645	3·7	2855	5·22	4911	3·55	2693	1·98	1315
3	....	....	8·2	10290	6·12	6369	3·45	2588	5·18	4849	3·45	2588	1·96	1300
4	....	....	8·4	10700	6·02	6199	3·38	2515	5·11	4741	3·4	2535	1·98	1315
5	....	....	8·9	11745	5·91	6022	3·3	2435	5·04	4635	3·4	2535	1·98	1315
6	....	....	9·37	12756	5·9	6005	3·3	2435	5·0	4575	3·37	2505	1·88	1241
7	....	....	9·87	13849	5·8	5830	3·28	2415	4·97	4530	3·3	2435	1·78	1171
8	....	....	9·97	14069	5·7	5675	3·21	2345	4·97	4530	3·2	2335	1·68	1101
9	....	....	9·89	13893	5·6	5510	3·2	2335	4·9	4425	3·1	2235	1·76	1157
10	....	....	9·92	13959	5·5	5355	3·3	2435	4·89	4411	3·3	2435	1·88	1241
11	....	....	9·9	14069	5·4	5195	3·5	2640	4·91	4440	3·3	2435	1·90	1255
12	....	....	9·91	13937	5·3	5035	3·7	2855	4·95	4500	3·08	2217	2·00	1330
13	....	....	9·81	13717	5·12	4755	3·8	2965	4·9	4425	3·0	2145	1·96	1300
14	....	....	9·67	13419	5·1	4725	4·0	3200	4·84	4338	3·0	2145	1·88	1241
15	....	....	9·37	12756	5·0	4575	4·3	3585	5·0	4575	2·9	2055	1·82	1199
16	....	....	9·17	12326	4·9	4425	4·49	3842	5·0	4575	2·8	1965	1·76	1157
17	6·5	7030	9·02	12003	4·8	4280	4·58	3967	5·0	4575	2·75	1923	1·76	1157
18	7·5	8895	8·96	11874	4·6	3995	4·8	4280	4·9	4425	2·7	1880	1·73	1136
19	7·6	9090	8·81	11556	4·5	3855	4·85	4353	4·7	4135	2·6	1795	1·78	1171
20	7·8	9485	8·68	11283	4·4	3720	4·9	4425	4·6	3995	2·5	1715	1·86	1227
21	7·75	9385	8·5	10905	4·3	3585	5·5	5355	4·4	3720	2·45	1675	1·87	1234
22	7·7	9285	8·32	10536	4·2	3455	5·12	4755	4·2	3455	2·4	1635	1·78	1171
23	7·7	9285	8·19	10270	4·1	3325	5·22	4911	4·0	3200	2·38	1614	1·70	1115
24	7·7	9285	8·0	9885	4·0	3200	5·31	5051	3·95	3140	2·38	1614	1·73	1136
25	7·75	9385	7·8	9485	3·9	3080	5·4	5195	3·85	3023	2·38	1614	1·87	1234
26	7·8	9485	7·6	9090	3·9	3080	5·4	5195	3·65	2800	2·3	1550	1·78	1171
27	7·85	9585	7·3	8510	3·8	2965	5·4	5195	3·5	2640	2·18	1465	1·78	1171
28	7·83	9545	7·1	8125	3·8	2965	5·39	5179	3·48	2619	2·18	1465	1·56	1017
29	8·4	10700	6·9	7755	3·65	2800	5·4	5195	3·5	2640	2·08	1390	1·48	961
30	8·6	9885	6·7	7390	3·68	2833	5·4	5195	3·57	2714	2·08	1390	1·38	892
31	....	....	6·5	7030	....	....	5·32	5067	3·6	2745	....	....	1·28	827

TABLE No. 55.

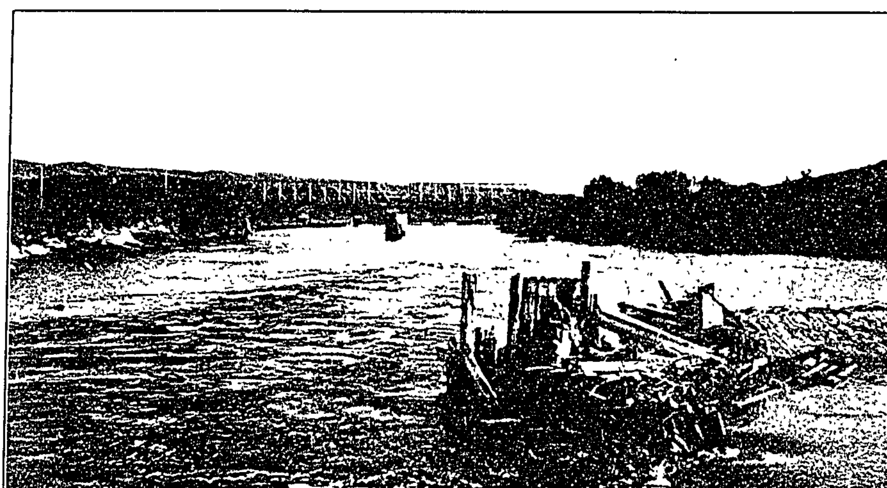
DISCHARGE MEASUREMENTS of Assiniboine River, at St. James, 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity	Gauge height.	Discharge.
1912.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
May 14	S. S. Scovil	1186	291	1227	4·78	4·75	5864
" 25	G. H. Burnham	1187	356	1160	4·81	5·33	7021
June 11	" "	1187	357	1608	4·87	5·90	7832
" 24	" "	1187	293	1118	4·33	4·22	4841
July 1	" "	1187	291	1087	4·07	3·89	4425
" 8	" "	1187	285	911	3·63	3·20	3308
" 23	" "	1187	285	863	3·08	2·71	2659
Aug. 3	W. G. Worden	1187	285	799	2·78	2·45	2221
" 27	" "	1187	280	728	2·63	2·17	1914
Sept. 24	A. Pirie	1187	290	1102	4·04	3·75	4450
Oct. 8	R. H. Nelson	1187	295	1429	4·31	4·73	6161
" 30	" "	1197	285	916	3·35	2·87	3063
Dec. 28	H. M. Nelson	1197	285	779	1·35	3·63	1052(1)
1913.							
Jan. 17	A. Pirie	1469	263	399	1·31	2·63	522(1)
Mar. 7	G. H. Burnham	1197	197	317	1·38	2·83	437(1)
May 3	E. Bankson	1469	360	2242	4·49	7·87	10056

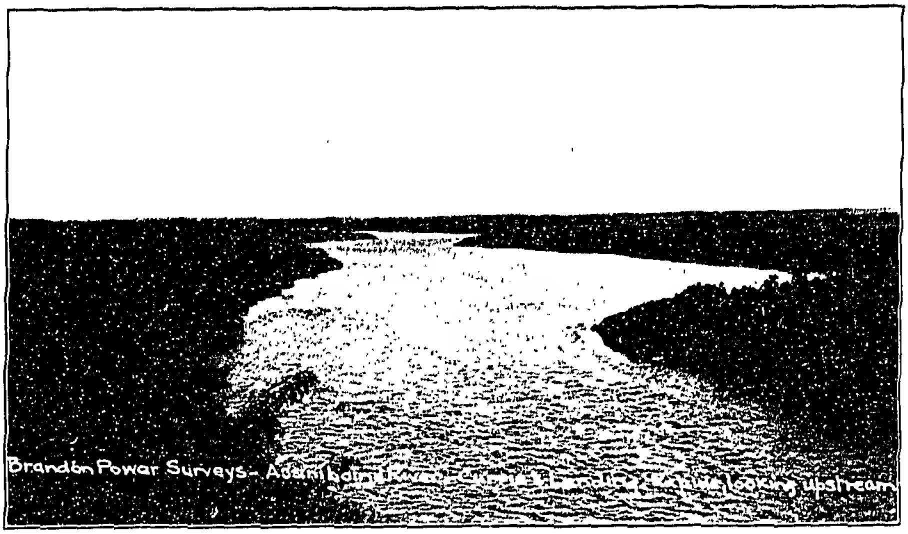
(1) Ice Cover



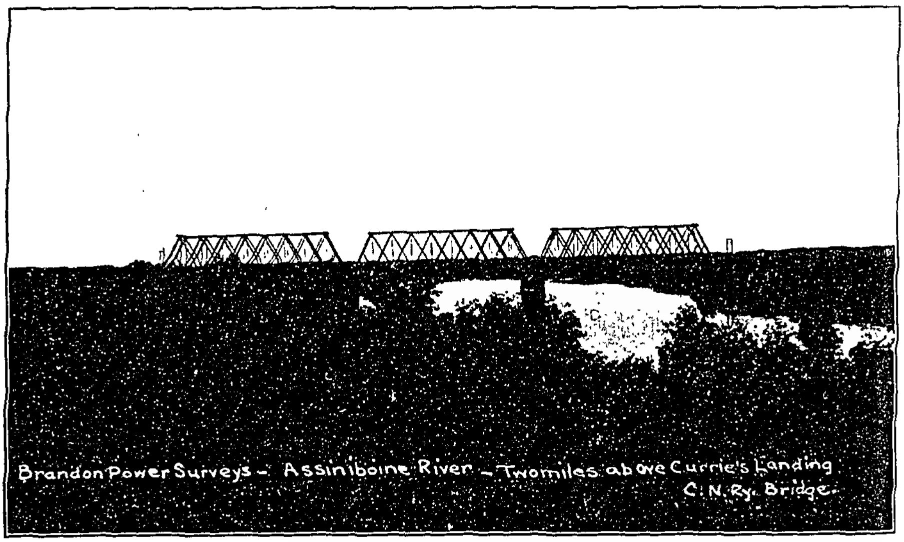
Assiniboine River. Downstream side of old Dam at Millwood



Assiniboine River. Looking downstream from site of old Dam at Millwood



Brandon Power Surveys - Assiniboine River - [illegible] looking upstream



Brandon Power Surveys - Assiniboine River - Two miles above Currie's Landing
C.N.Ry. Bridge.

THE LITTLE SASKATCHEWAN.

A.—LOCATION AND DIRECTION.

The Little Saskatchewan (see plate No. 12), rises in the southerly part of Riding Mountain Forest reserve and flows in a southeasterly direction until it reaches the town of Minnedosa. At this town the river bends through almost a right angle, and flows in a southwesterly direction until within about fifteen miles of its mouth when it again resumes its original course to the southeast and joins the Assiniboine river. The point of junction with the latter river is eight miles west of the city of Brandon and almost directly south of the head-waters.

B.—RIVER BASIN.

The watershed of the river covers an area of 1,640 square miles, the greater part of which is hilly and undulating. The width of the basin in the upper reaches approximates forty-five miles, and its length from mouth to head-waters, sixty miles. In the country forming the upper basin of the river are to be found numerous small lakes draining into the upper tributaries, and it is in this section that most of the drainage is obtained, as in the lower reaches of the river very few tributaries are met with. The largest single drainage entering the river is encountered about thirteen miles north of the town of Minnedosa and is called the Rolling river.

C.—NATURE OF BANKS.

The course of the river throughout is very winding and though, as above noted, the length of the basin from head-waters to mouth is sixty miles, the actual length of the river itself is one hundred and twenty-five miles.

The valley of the river is well marked throughout its length. The banks vary in height from one hundred to three hundred feet, while the width between banks varies from one thousand feet to a mile and a quarter.

The nature of the soil is mostly a sandy clay, and, in some parts, particularly on the lower levels, is thickly strewn with boulders. This soil generally overlays a stratum of gravel and, at a depth of about five feet, blue clay is encountered in most sections. Pockets of quicksand are also met with, but these are not common.

D.—WIDTH OF RIVER AND NATURE OF BED.

The river, almost throughout its entire length, flows over a bed composed of fine gravel and sand, though in some localities it is thickly covered with large boulders.

In width the natural bed varies from fifty to ninety feet.

No rock outcrops have been noted, and it is not likely that rock will be met with in any part of the river.

E.—TIMBER AND VEGETATION.

In the upper reaches of the river a considerable amount of valuable timber has been observed but, with this exception, very little marketable timber is to be had, the country being well settled and the land mostly broken throughout the entire basin. The unbroken land is mostly covered with small poplar and scrub.

The basin of this river is probably one of the oldest settled in the province. The soil is rich and the section north of Minnedosa is noted for its oat crops, while in the southern part, wheat forms the larger proportion of the crop.

F.—TRANSPORTATION AND ACCESSIBILITY.

The river is not large enough for navigation except by row-boat or canoe. Throughout its course, with the possible exception of the extreme upper portion of its basin, the roads are in very good condition, and the river easily accessible from same. It is also in close touch with the different railroads throughout the lower one hundred miles of its course, and is crossed by them at eight different points. At no place in this distance is the river distant from a railroad by more than six miles.

G.—SETTLEMENTS.

The land throughout the basin is well settled and, in the course of the river, are encountered the settlements of Rivers, Gautier, Rapid City, Riverdale, Minnedosa, Rolling River and Elpinstone. Of these the largest and most important are Minnedosa, Rapid City, the former having a population of about seventeen hundred and the latter about five hundred and eighty.

H.—RUN-OFF.

(*a*) *Rainfall.*—Rainfall records for the town of Minnedosa, covering a period of thirty-two years, give the mean annual precipitation as being eighteen inches.

(*b*) *Discharge Measurements.*—A gauging station was established on this river at Riverdale by the Manitoba Hydrographic Survey during January of the present year, and since that time investigations as to flow during the different stages of the river have been made.

These investigations include eight meterings, the results of which are given in table No. 56.

A record of the daily gauge heights has also been kept, and these, with their assumed discharges, will be found on the daily discharge table No. 57.

I.—HIGH AND LOW WATER.

As is shown in table No. 57, it will be seen that there is an extreme variation between flood and low water of slightly over five feet. The flood conditions lasted on the river for a period of three weeks, and, with the exception of this time, the variation in the stage of the river amounted to a maximum of 2·7 feet.

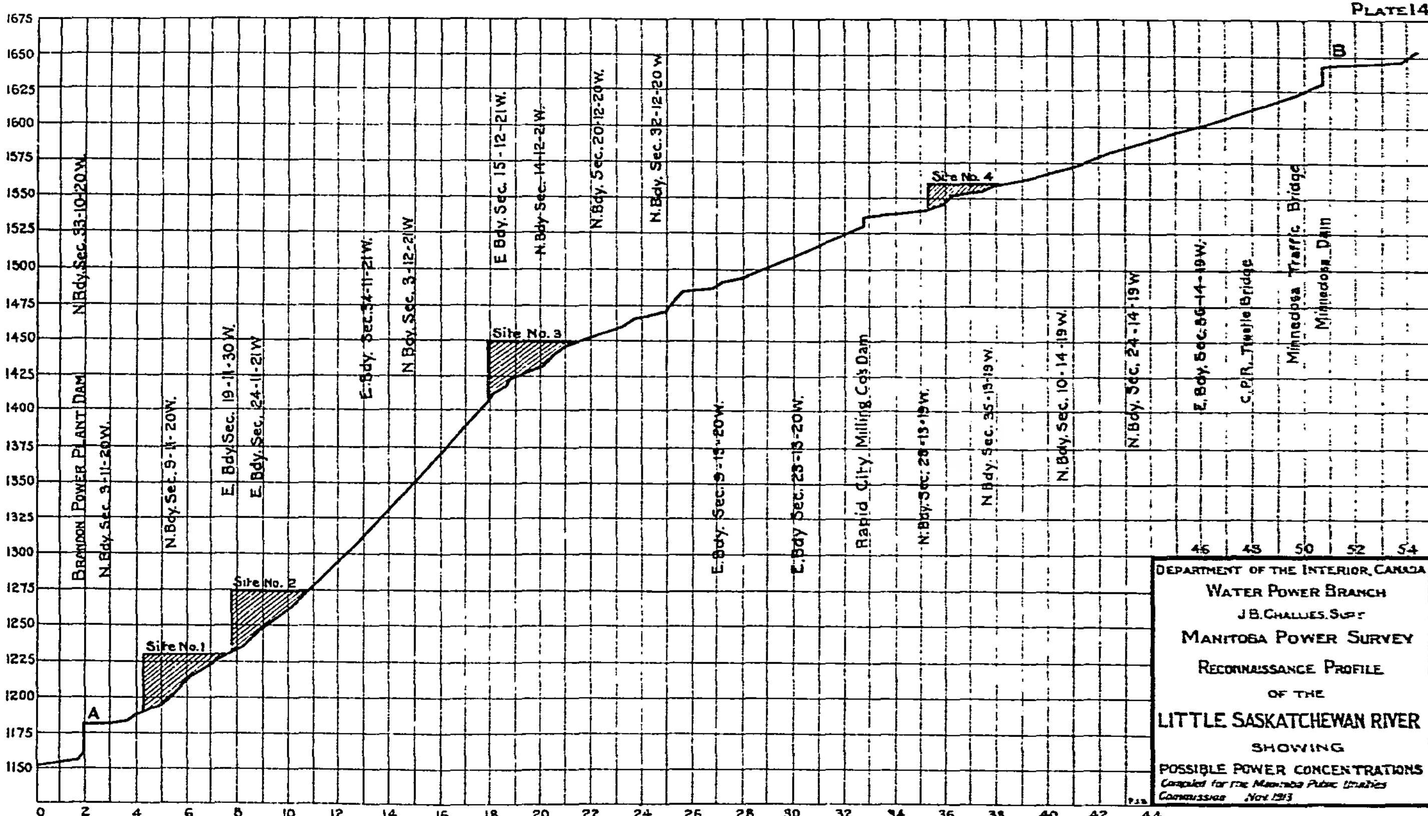
J.—SURVEYS.

(*a*) The land throughout the drainage area has been surveyed and subdivided by the Dominion Land Survey.

(*b*) A reconnaissance survey for the purpose of locating available water-power sites was made on the river during the summer of this year by the Manitoba Power Survey, under the direction of the late G. H. Burnham.

Location work was carried out from the Assiniboine to a point about four miles above the town of Minnedosa, and investigations as to possible storage were made up to the head-waters above the town of Elphinstone. The accompanying map, plate No. 12, and profile of the river, plate No. 14, give the location of four possible dam sites and also the two existing developments, as investigated by this survey.

PLATE 14



DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT.
MANITOBA POWER SURVEY
RECONNAISSANCE PROFILE
OF THE
LITTLE SASKATCHEWAN RIVER
SHOWING
POSSIBLE POWER CONCENTRATIONS
Compiled for the Manitoba Public Utilities Commission Nov. 1913

Douglas L. McLean Chief Engineer
Stuart S. Scovil Asst Chief Engineer

K.—STORAGE.

The lake and stream areas, with their accompanying low land and marshes in the upper basin which could be utilized for storage purposes, are as follows:—

	Acres.
Andy lake, including Big Jackfish creek..	1,000
Jackfish lake..	1,280
Bottle and Spruce lakes..	1,100
Squaw creek..	2,500
Clear lake..	8,960
Proutts lake..	350
Stuarts lake..	650
Oak lake..	1,300
Thomas lake..	2,000
Beauford lake..	600
Long lake....	1,800
Sandy lake..	2,500

The total surface area obtainable for storage purposes in connection with these lakes is 24,040 acres.

The amount of storage per foot on the above area is 1,047 billion cubic feet.

L.—MASS CURVE.

From mass curve studies, plate No. 15, made in connection with the discharge data obtained during the year of 1913, we find that to maintain a uniform discharge of 230 second-feet, there would be required a properly regulated storage on the head-water lakes of 3·16 billion cubic feet, or an average depth of 3·01 on the above-mentioned storage areas.

M.—WATER-POWER.

There is a difference in elevation of 490 feet between the water levels at the point of junction of the Little Saskatchewan with the Assiniboine, and a point four miles above the town of Minnedosa.

In this length of the river the possibility of concentrating a portion of the natural fall at six different locations has been investigated. At two of these points development work has been done, and these, with the other possible developments and their estimated horse-powers, are listed below.

Based on estimates of flow for the year ending October 31, 1913, the following table gives the power available at an 80 per cent efficiency, and is computed for a low flow of 50 second-feet, and also for an estimated regulated flow of 230 second-feet.

Power Site.	Estimated Horse Power at 80 Per Cent Efficiency.		
	Head.	Low Flow 50 sec.-ft.	Regulated Flow 230 sec.-ft.
Brandon Electric Light Co.	33	149	690
Minnedosa Power Co.	14	108	504
Dam Site No. 1	40	180	840
" " 2	45	203	945
" " 3	47	212	987
" " 4	20	90	420

X.—POWER DEVELOPMENTS.

(a) *The Brandon Electric Light Co.*

The Brandon Electric Light Company own and operate a water-power on the river about half a mile above its junction with the Assiniboine.

This plant is used throughout the summer months, but is shut down and held as a possible auxiliary to the company's steam plant during the winter. This reversal of the usual custom is accounted for by the fact that the company sell their exhaust steam through the winter months for heating purposes, and in that way actually have a source of revenue above the cost of fuel used for generating power.

This development comprises an earth dam 25 feet high and 450 feet long, with a wooden spillway 68 feet wide.

The power-house is a frame building erected immediately below the dam.

Plant has been installed here for the development of from 400 to 600 k.w. under a head of 33 feet.

(b) *The Minnedosa Power Co.*

The location on the river which has been developed by the Minnedosa Power Company is situated within half a mile of the town of Minnedosa.

Work was commenced on this development in January of 1910 and the plant, though not completed, started operating under a head of 17 feet in the spring of the present year. It is claimed that this head is increased to 24 feet under completed conditions. This head has been made possible by the erection of an earth dam, 1,800 feet long.

A frame generator and turbine house is situated about 400 feet below the dam, and the water is carried from the intake to a 450 horse-power turbine, through a 6-foot wood stave pipe line. (See page 123.) Provision has been made for doubling the capacity of the plant as the demand for power increases. At the opposite end of the dam to the intake is located a concrete spillway, 60 feet wide.

It is stated that the company has the right to raise the level of the water in Clear lake 5 feet for the purpose of obtaining storage to carry the plant over periods of low flow, and a photo of the timber dam erected for this purpose is shown on page 123.

TABLE No. 56.

DISCHARGE MEASUREMENTS of Little Saskatchewan River, at Riverdale, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
			Feet.	Sq. Ft.	Ft. per sec.	Feet.	Sec.-ft.
Jan. 24..	G. Lamb	1374	77	68	0·85	3·17	57[1]
Feb. 18..	A. Pirie	1462.9	65	69	0·89	4·33	61
Apr. 16..	S. S. Scovil	1469	95	318	3·03	5·15	966
May 8..	E. Bankson	1469	94	241	2·55	4·2	617
July 1..	A. Pirie	1496	93	225	1·91	3·74	430
Aug. 8..	W. J. Ireland	1469	87	154	1·01	3·18	168
Sept. 11..	W. J. Ireland	1469	88	134	0·67	2·84	89
Oct. 17..	C. O. Allen	1435	81	117	0·73	2·88	85

[1]Ice measurement

TABLE

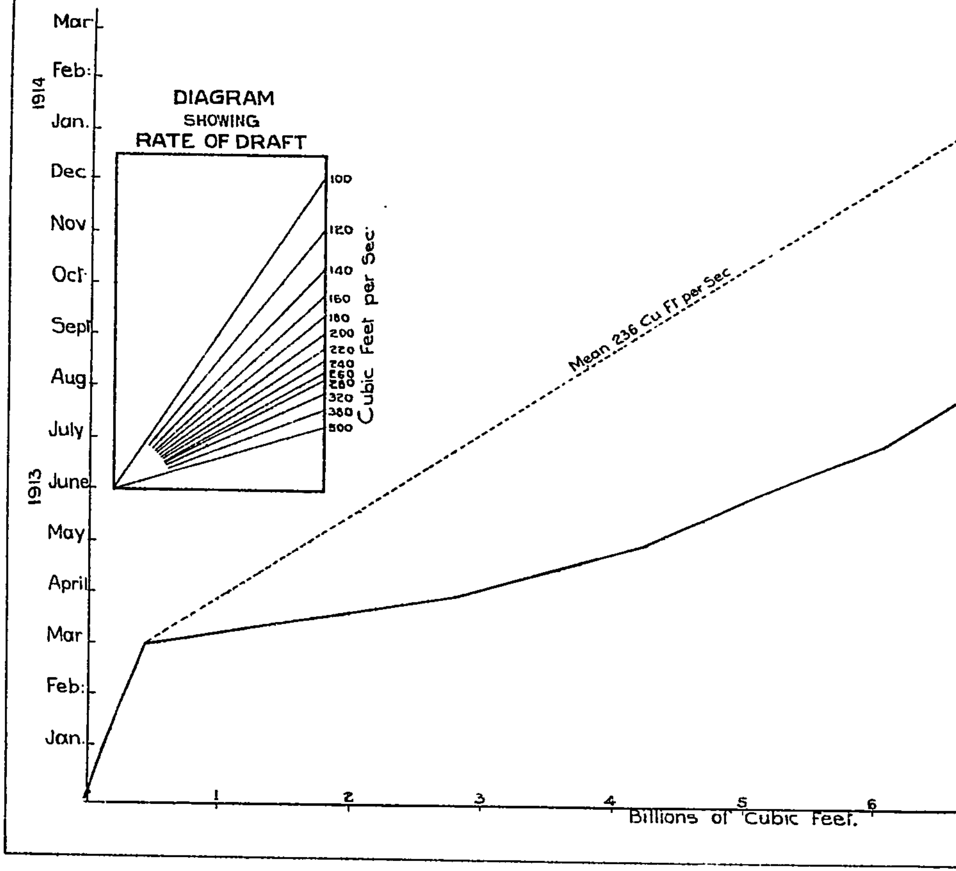
DAILY GAUGE HEIGHT AND DISCHARGE, Little

Day.	January.		February.		March.		April.		May.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	......	......	......	......	......	......	4·10	......	4·80	835
2	......	......	......	......	......	......	4·16	......	4·70	794
3	......	......	......	......	......	......	4·36	......	4·96	901
4	......	......	......	......	......	......	4·56	......	4·36	655
5	......	......	......	......	......	......	4·48	......	4·95	896
6	......	......	4·40	......	4·16	......	4·53	......	4·43	683
7	......	......	......	......	......	......	4·58	......	4·20	589
8	......	......	......	......	......	......	4·62	......	4·20	589
9	......	......	......	......	......	......	4·66	......	4·11	552
10	......	......	......	......	......	......	4·70	......	4·10	548
11	......	......	......	......	......	......	6·10	1368	4·60	753
12	......	......	......	......	......	......	7·50	1942	4·30	630
13	......	......	4·20	......	4·50	......	6·70	1614	4·00	507
14	......	......	......	......	......	......	6·00	1327	4·00	507
15	......	......	......	......	......	......	5·20	999	4·00	507
16	......	......	......	......	......	......	5·42	1089	3·90	467
17	......	......	......	......	......	......	5·31	1044	3·90	467
18	......	......	4·33	......	......	......	5·10	958	3·29	223
19	......	......	......	......	......	......	5·71	1208	3·29	223
20	......	......	4·93	......	4·63	......	5·92	1294	3·19	184
21	......	......	......	......	......	......	5·61	1167	3·90	467
22	......	......	......	......	......	......	5·21	1003	3·88	459
23	......	......	......	......	......	......	5·51	1126	3·78	419
24	3·17	......	......	......	......	......	5·11	962	3·80	427
25	......	......	......	......	......	......	5·90	1286	3·97	495
26	......	......	......	......	......	......	5·10	958	3·87	455
27	......	......	4·44	......	4·95	......	5·70	1204	3·80	427
28	......	......	......	......	......	......	5·30	1040	3·80	427
29	......	......	......	......	......	......	5·20	999	3·80	427
30	2·95	......	......	......	......	......	4·00	507	3·80	427
31	......	......	......	......	......	......	......	......	3·18	180

No. 57.

Saskatchewan River, near Riverdale, Man., for 1913.

June.		July.		August.		September.		October.		
Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Day.
Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	
3·77	415	3·80	427	3·60	347	3·00	126	2·50	32	1
3·77	415	3·50	307	3·40	267	2·49	31	2·60	44	2
3·70	387	3·60	347	3·40	267	3·00	126	2·90	101	3
3·86	451	3·46	291	3·44	283	2·69	58	2·28	13	4
3·80	427	3·80	427	3·30	227	2·49	31	2·90	101	5
3·20	187	3·60	347	3·20	187	2·28	13	2·80	78	6
3·50	307	3·80	427	3·30	227	2·90	101	2·80	78	7
3·85	447	3·47	295	3·92	475	2·70	59	2·90	101	8
3·60	347	3·80	427	3·61	351	2·90	101	2·47	29	9
3·95	487	3·56	331	3·83	439	2·88	96	2·90	101	10
3·10	154	3·80	427	3·30	227	2·88	96	2·68	56	11
3·48	299	3·48	299	3·20	187	2·24	12	2·90	101	12
3·30	227	3·70	387	3·00	126	2·50	32	2·70	59	13
3·40	267	3·48	299	3·20	187	2·80	78	2·90	101	14
3·30	227	3·90	467	3·10	151	2·44	26	2·80	78	15
3·70	387	3·29	223	3·10	154	2·45	27	2·27	13	16
3·40	267	3·80	427	3·10	154	2·50	32	2·47	29	17
3·47	295	3·90	467	2·89	99	2·80	78	2·80	78	18
3·80	427	4·00	507	3·20	187	2·80	78	2·70	59	19
3·30	227	3·90	467	3·22	195	2·45	27	2·68	56	20
3·14	167	3·49	303	3·42	275	2·50	32	2·87	94	21
3·62	355	3·90	467	3·83	439	2·83	85	2·68	56	22
3·73	399	3·86	427	3·81	431	2·90	101	2·88	96	23
3·60	347	3·66	371	3·30	227	2·80	78	2·48	30	24
3·23	199	3·26	211	3·42	275	2·80	78	2·80	78	25
3·45	287	3·60	347	3·10	154	2·50	32	2·28	13	26
3·65	367	3·60	347	3·00	126	2·60	44	2·48	30	27
3·60	347	3·85	447	2·89	99	2·60	44	2·80	78	28
3·70	387	3·60	347	3·00	126	2·90	101	2·70	59	29
3·70	387	3·46	291	3·40	267	2·40	22	3·00	126	30
....	....	3·70	387	3·00	126	....	....	3·41	271	31



DEPARTMENT OF THE INTERIOR, CANADA.
WATER POWER BRANCH
J. B. CHALLIES, SUPT.

MANITOBA POWER SURVEY

LITTLE SASKATCHEWAN RIVER

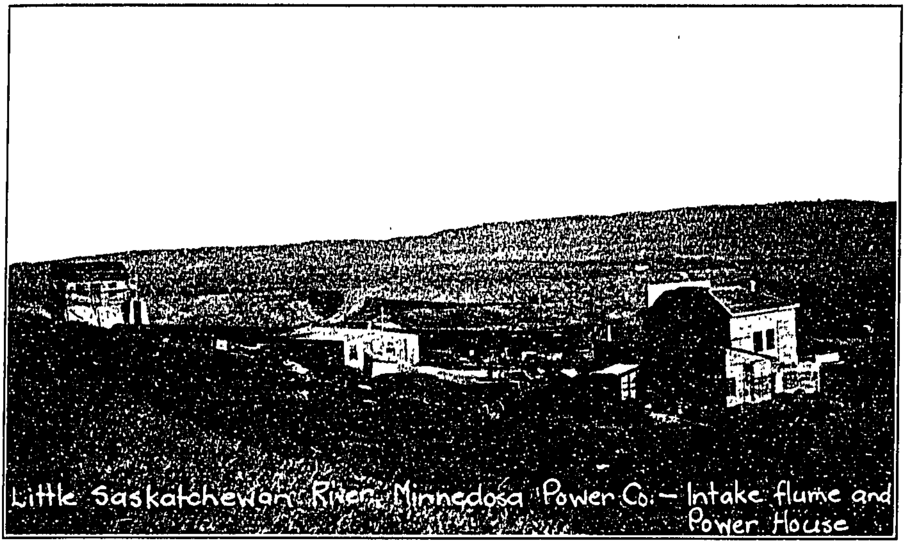
MASS CURVE OF
ESTIMATED RUNOFF

Compiled for the Manitoba Public Utilities Commission.

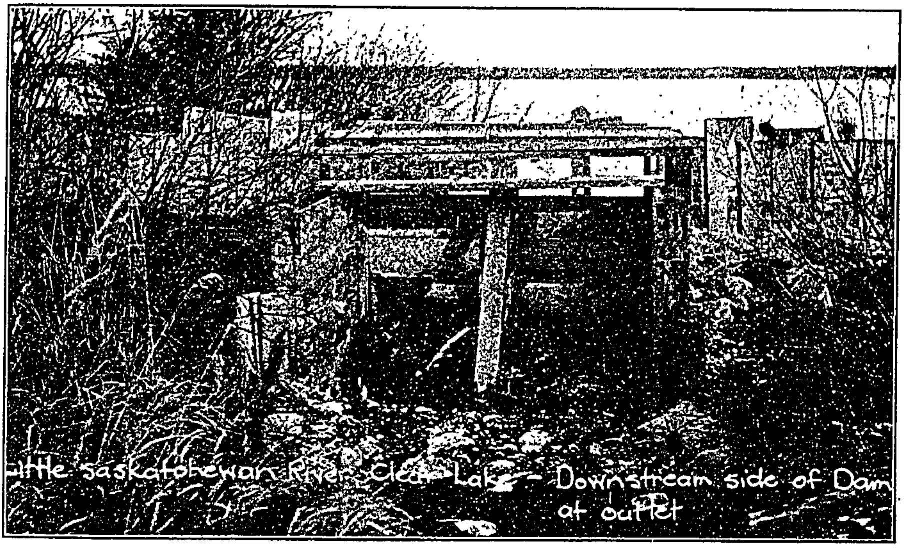
November, 1913.

Douglas L. McLean Chief Engineer

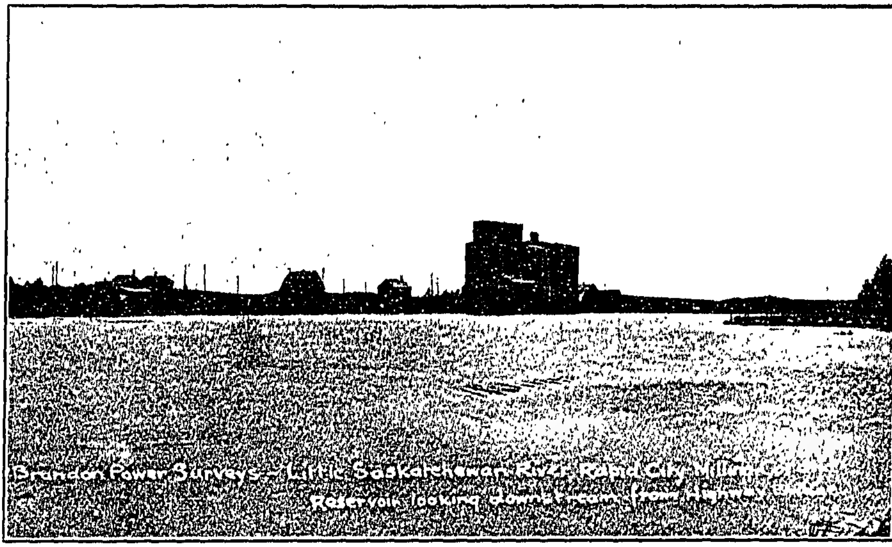
Asst. Chief Engineer



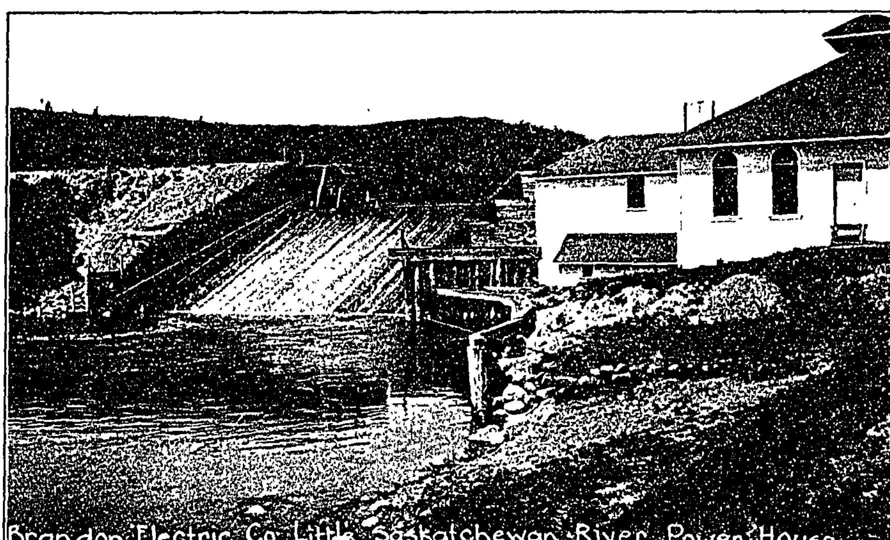
Little Saskatchewan River, Minnedosa Power Co. – Intake flume and Power House



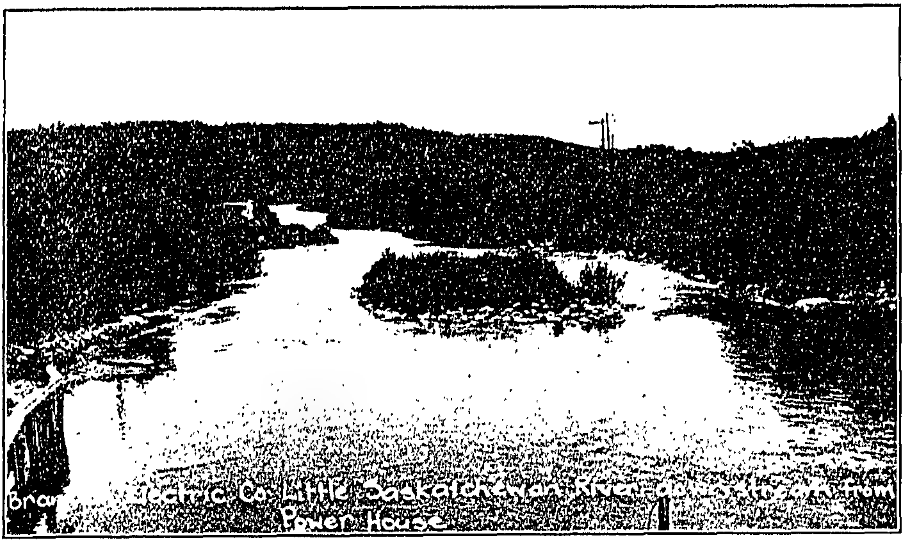
Little Saskatchewan River – Clear Lake – Downstream side of Dam at outlet



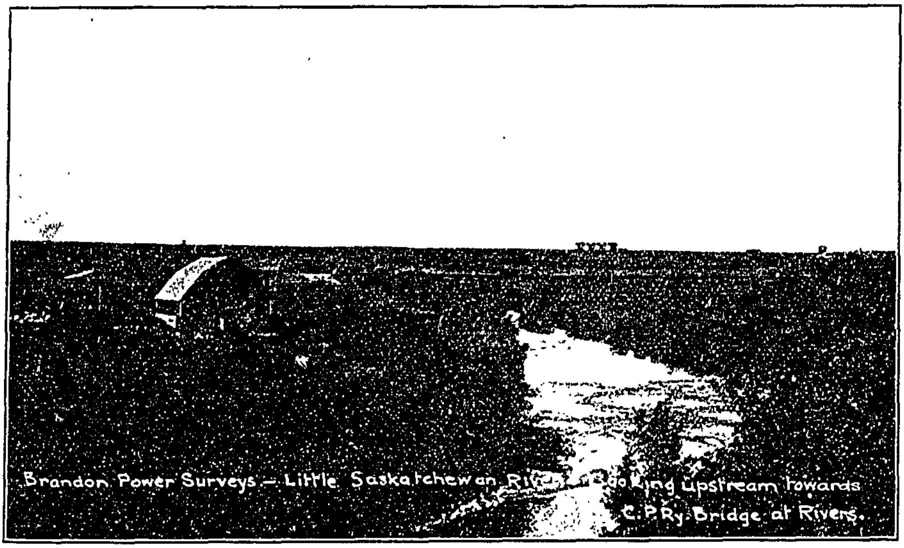
Brandon Power Surveys – Little Saskatchewan River, Rapid City Milling Co.
Reservoir looking downstream from highway



Brandon Electric Co. Little Saskatchewan River, Power House

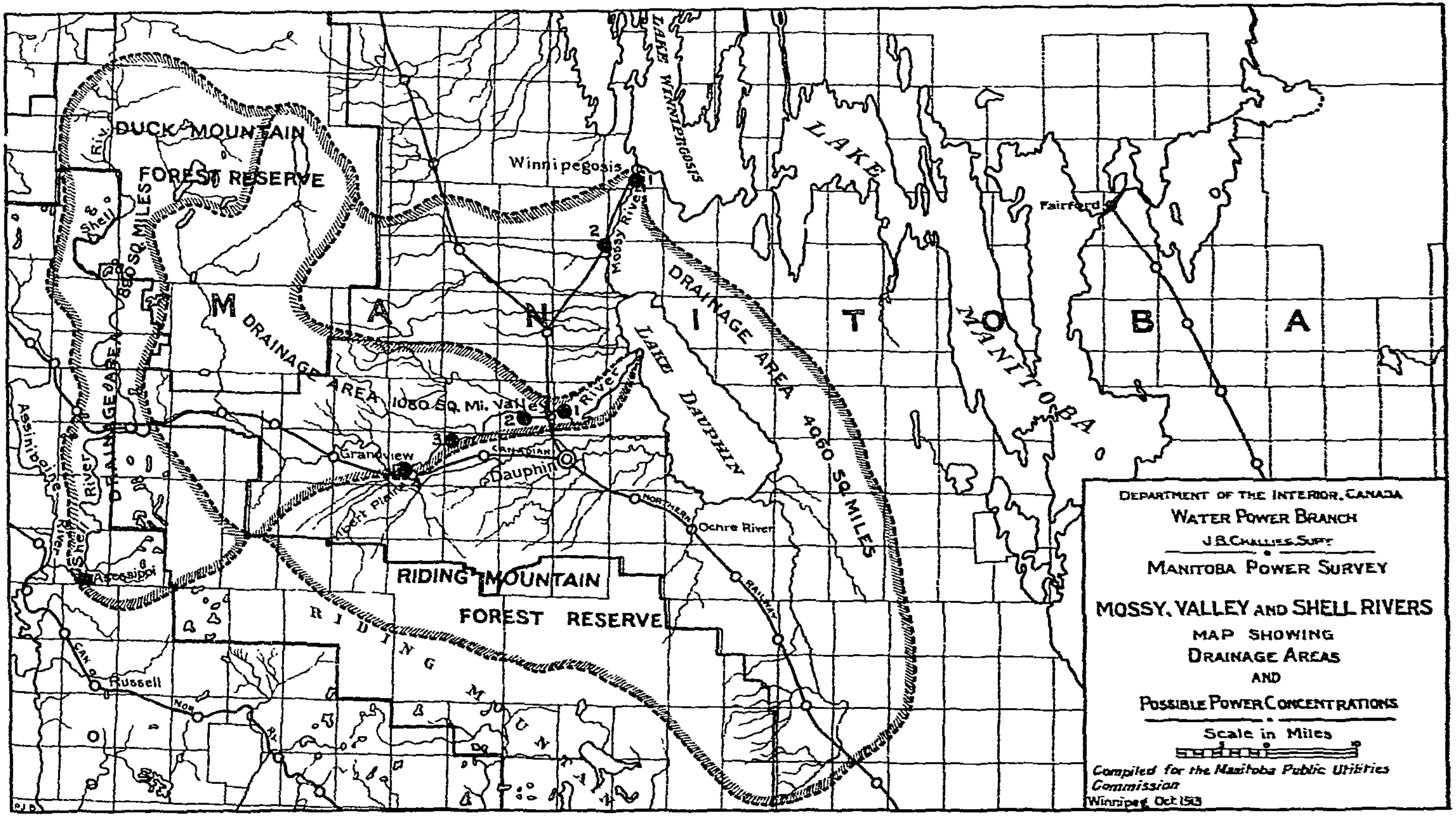


Bran... ...ectric Co. Little Saskatchewan River ... from Power House



Brandon Power Surveys.— Little Saskatchewan River — Looking upstream towards C.P.Ry. Bridge at Rivers.

PLATE 16



Douglas L. McLean Chief Engineer
Stuart S. Scott Asst Chief Engineer

WATER-POWERS OF MANITOBA.

CHAPTER V.

RIVERS IN WESTERN CENTRAL PORTIONS OF MANITOBA.

CHAPTER V.

RIVERS OF WESTERN CENTRAL PORTION OF MANITOBA.

VALLEY RIVER.

A.—LOCATION.

The Valley river, so called since it flows in the valley between the Riding and Duck mountains, rises in the Duck Mountain Forest Reserve and discharges into lake Dauphin. (*See* plate No. 16.)

B.—RIVER BASIN.

Singoosh lake, which lies in the northerly part of the Duck mountains, is stated to be the source of the river. From this lake the flow is in a southwesterly direction to East Angling lake, into which the tributary drainage from Laurie and West Angling lakes enters from the north. From East Angling lake the river flows southerly a distance of some 16 miles, and then bends in an easterly direction, continuing this latter course until it empties into lake Dauphin. Near the easterly bend, Short creek, which rises in Riding Mountain Forest reserve and drains several small lakes, enters the Valley river from the west. Below this the main drainage to the river enters from the north, chief among the tributaries being the Drifting river, which joins the Valley river some three miles west of Valley river station on the Canadian Northern railway.

C.—NATURE OF BED AND BANKS.

In the reaches below the Duck Mountain Forest reserve the river flows in the valley lying between the Duck and Riding mountains, the banks vary in height from 15 to 85 feet, while the width of the bottom land ranges from 700 to 2,000 feet, widening in some few places to 3,000 feet. The river at ordinary summer stages has a width varying from 100 to 200 feet; the banks are composed of yellow clay overlying a bed of gravel and boulders. Investigations carried on at several points in that portion of the river lying between Gilbert Plains and Valley River station, have shown a depth of clay varying from 6 to 30 feet overlying the gravel strata. The bed of the river is of gravel, strewn with boulders.

D.—TIMBER AND VEGETATION.

In the upper watershed there is considerable growth of valuable timber, comprising spruce, jackpine and poplar. Lower down the river the valley bottom and banks are covered with a growth of scrub oak, poplar and briar. Very little clearing has been done in the immediate vicinity of the river, but grain growing and mixed farming are carried on to a considerable extent in the adjacent country.

E.—HIGH AND LOW WATER.

High water usually occurs at the time of the spring break-up in April; the river, however, is subject to extreme fluctuations in the open-water season, heavy rains in

the head-water giving rise to floods in the lower valleys. Low water occurs in the fall and winter months.

F.—TRANSPORTATION AND ACCESSIBILITY.

Due to shoals and rapids, navigation of the river is impossible other than by row-boat or canoe. The river is accessible by many township roads and is also crossed by the Canadian Northern railway at Valley river, Grandview and Stravel, and in no place between these crossings is it more than five miles distant from the railway.

G.—SETTLEMENTS.

The country adjacent to the Valley river is well settled by farmers, while several thriving villages, such as Gilbert Plains, Grandview and Valley River are in the immediate vicinity. The town of Dauphin, which is the center of this agricultural district, lies some six miles south from the nearest point on the river.

H.—SURVEYS OF THE RIVER.

Outside the boundaries of the forest reserves, all townships have been surveyed. A geological survey of the river from lake Dauphin to Angling lake was made in the year 1887 by the Geological Survey of Canada. In October, 1912, a meter station was established at the Canadian Northern Railway bridge near Valley River post office by the Manitoba Hydrographic Survey. In the following summer a reconnaissance survey of the power possibilities of that portion of the river from Gilbert Plains to a point some four miles below Valley River post office was carried on by the Manitoba Power Survey, operating under the Water-power Branch of the Department of the Interior. In the fall of the same year a preliminary investigation of the storage possibilities of the upper watershed was made by Mr. D. B. Gow, who previously had been in charge of the field party carrying on the power survey.

I.—RUN-OFF.

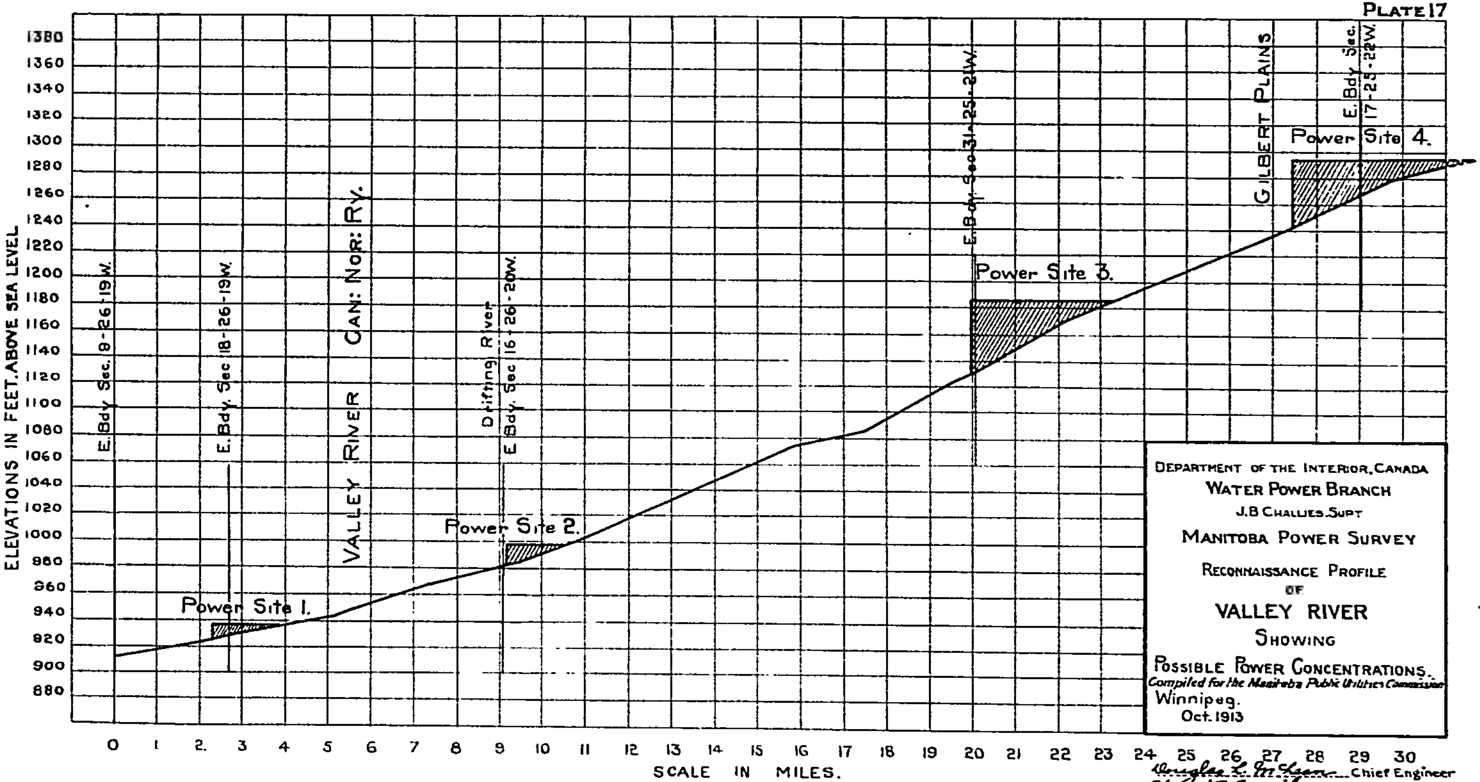
(*a*) *Rainfall.*—Rainfall records extending over a sufficient period of time are not available for this drainage area. Records of rainfall at Minnedosa, which lies to the southeast of the Valley River basin, but to which, to a great extent, the same physical conditions apply, show a mean annual rainfall of 18 inches for a period of 32 years.

(*b*) *Discharge Measurements.*—Measurements of the flow of the river have been made at the C.N.R. bridge, near Valley River post office, by the Manitoba Hydrographic Survey during the past year, the results of this work being given in table No. 58. An estimate of the daily discharges for the year ending October 31, 1913, as given in tables No. 59 and No. 60, shows a low flow of 20 second-feet occurring in January, February and March. The maximum flow recorded at the time of the spring break-up was 2,760 second-feet, but during the month of July the river reached flood stage, due to exceptionally heavy rains, and showed a maximum discharge of some 3,500 second-feet.

J.—STORAGE POSSIBILITIES.

No definite information is available with reference to all the lakes lying in the head-waters of the drainage basin. From a reconnaissance investigation of the Angling lakes, it would be possible to obtain a 5-foot storage on North Angling lake and a 3-foot storage on East Angling lake, the latter lake being a collecting basin of the major portion of the upper drainage. In the case of the former lake, the topo-

PLATE 17

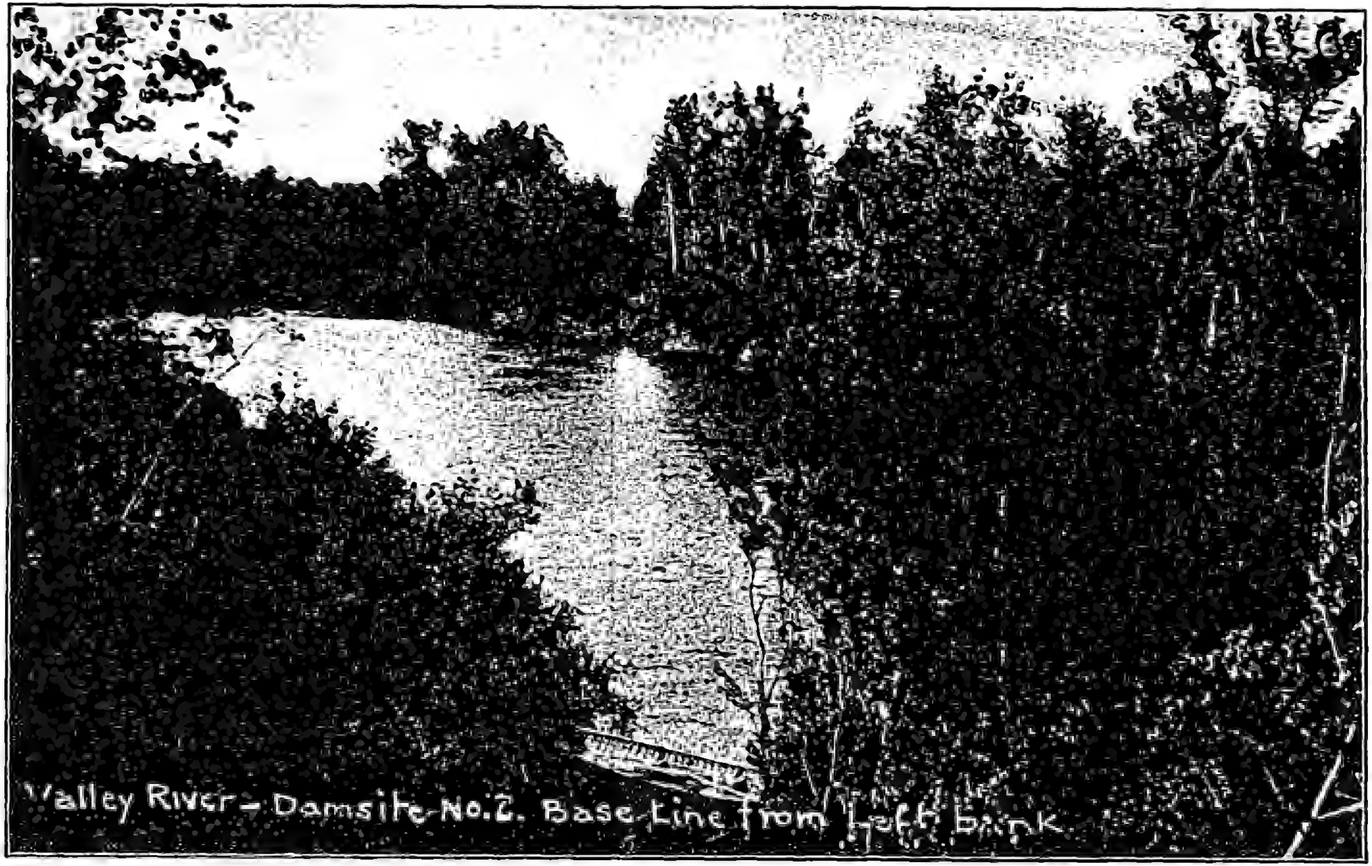


DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT.
MANITOBA POWER SURVEY
RECONNAISSANCE PROFILE
OF
VALLEY RIVER
SHOWING
POSSIBLE POWER CONCENTRATIONS.
Compiled for the Manitoba Public Utilities Commission
Winnipeg.
Oct. 1913

Douglas L. McLean Chief Engineer
[illegible] Asst. Chief Engineer

Valley River. Mc.Pherson Dam site . . Reach above and below D.L. July 29th, 1913

Valley River, at Outlet of East Angling Lake


Valley River - Damsite No. 2. Base Line from Left bank

graphical features of the shores and outlet would permit of greater depth of storage, but the depth as given has been estimated as being all that the tributary run-off would require. This same feature applies to Singoosh lake, which, though it has not as yet been investigated, is stated locally to be capable of a storage of 10 feet. While further storage might be obtained on other small lakes, the following table gives an estimate of that available on the three above-mentioned lakes:—

Lake.	Area in Acres.	Depth of Storage in Feet.	Storage in Cubic Feet.
East Angling	288	3	37,700,000
North Angling	230	5	50,100,000
Singoosh	2,880	3	376,500,000
Total		......	464,300,000

From mass curve studies of the run-off of the Valley river for the year ending October 31, 1913, it is estimated that the low flow of the river during winter months could be increased from 20 second-feet, as found in 1913, to 60 second-feet by the utilization of this storage.

K.—WATER-POWER.

The following table gives the estimated power available at four possible power sites in that portion of the river investigated as shown on profile plate No. 17.

The estimated power, based on an 80 per cent efficiency, has been computed under three separate headings:—

(1) On a minimum flow of 20 second-feet as recorded during the winter of 1912-1913.

(2) On a regulated flow of 60 second-feet, it being estimated that the low flow could be increased by regulation to this amount.

(3) On a flow of 100 second-feet, this being the lowest mean monthly flow for a period of six months from April to September, inclusive, and consequently the estimated power under this heading only applies to the period as given.

All estimates of power are based on run-off data for the year ending October 31, 1913, and as these records do not cover an extended period of time, the estimates of the flow are therefore subject to a revision:—

Power Site.	Estimated Horse Power on 80% Efficiency.			
	Head.	Min. Flow.	Regulated Flow.	Lowest monthly mean, 6 mos., April-Sept.
No. 1	19	34	102	172
No. 2	19	34	102	172
No. 3	56	101	303	504
No. 4	52	94	282	468
Total horse-power	....	263	789	1,316

TABLE No. 58.

Discharge Measurements of Valley River, at Valley River, 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean Velocity.	Gauge height.	Discharge.
1912.			Feet.	Sq. Ft.	Ft. per sec.	Feet.	Sec.-ft.
Oct. 25	W. G. Worden	1196	57	157·2	2·09	2·94	328
1913.							
Feb. 13	A. Pirie	1462	45	80·0	0·25	2·60	20
April 14	"	1186	157	608·6	3·78	6·17	2300
" 14	"	1186	157	608·1	4 10	6·17	2244
" 14	"	1186	154	585·6	3·71	6·03	2182
June 6	E. Bankson	1469	56	146·8	2·01	2·80	296
" 17	G. Ebner	1186	51	126·9	1·48	2·43	188
July 7	A. Pirie	1496	193	777·9	3 86	7·40	3006
" 11	"	1496	144	525·4	4·11	5·95	2163
Aug. 14	G. Ebner	1196	53	128·0	1·68	2·40	2150
" 22	W. J. Ireland	1469	60	162·7	2·46	2·39	399
Sept. 17	"	1469	52	98·8	1·09	1·80	107
Oct. 14	C. O. Allen	1435	51	84·8	0·82	1·62	69

TABLE No. 50.

DAILY GAUGE HEIGHT AND DISCHARGE, Valley River, at Valley River, 1912.

Day.	October.		November.	
	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1				
2			2·59	
3			2·54	
4			2·50	
5			2·61	
6			2·66	
7			2·61	
8			2·54	
9			2·50	
10			2·47	
11			2·36	
12			2·41	
13			2·51	
14			2·47	
15			2·41	
16			2·34	
17			2·28	
18			2·18	
19			2·14	
20			2·14	
21			2·17	
22			2·32	
23			2·38	
24			2·33	
25	2·94	371	2·26	
26	2·93	367	2·23	
27	2·88	347	2·19	
28	2·79	307	2·09	
29	2·72	286	2·13	
30	2·69	277	2·12	
31	2·67	271	2·09	

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE.

Day.	February.		March.		April.		May.		June.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	......	......	......	......	......	......	3·91	906	2·31	172
2	......	......	......	......	......	......	3·71	786	2·31	172
3	......	......	......	......	3·54	......	3·74	804	2·31	172
4	......	......	......	......	5·32	......	3·67	762	3·45	630
5	......	......	......	......	6·02	......	3·71	786	2·81	319
6	......	......	2·61	......	6·80	......	3·61	726	2·93	367
7	......	......	......	......	6·14	......	4·03	978	2·83	327
8	......	......	......	......	5·41	1,806	4·03	978	2·24	158
9	......	......	......	......	4·52	1,272	4·06	996	2·24	158
10	......	......	......	......	4·44	1,224	3·93	918	2·24	158
11	......	......	......	......	5·77	2,010	3·94	924	3·04	411
12	......	......	......	......	5·57	1,890	3·80	840	2·93	367
13	2·60	......	......	......	7·00	2,760	3·46	636	2·81	319
14	......	......	2·61	......	6·01	2,160	3·66	756	2·73	289
15	......	......	......	......	5·91	2,100	3·71	786	2·51	223
16	......	......	......	......	5·67	1,950	3·71	786	2·51	223
17	......	......	......	......	5·71	1,980	3·74	804	2·43	201
18	......	......	......	......	5·42	1,812	3·53	678	2·58	244
19	......	......	......	......	5·61	1,920	3·89	894	2·33	178
20	2·61	......	......	......	5·51	1,860	3·60	720	2·30	170
21	......	......	2·61	......	5·31	1,746	3·50	660	2·24	158
22	......	......	......	......	5·18	1,668	2·61	253	2·20	150
23	......	......	......	......	5·07	1,602	2·41	197	2·18	146
24	......	......	......	......	4·71	1,386	2·31	172	2·73	289
25	......	......	......	......	4·31	1,146	2·31	177	2·71	283
26	......	......	......	......	3·91	906	2·31	172	2·50	220
27	2·62	......	2·61	......	3·51	666	2·31	172	2·50	220
28	......	......	......	......	3·11	415	2·31	172	2·63	259
29	......	......	......	......	3·93	918	2·31	172	2·68	274
30	......	......	......	......	3·81	846	2·31	172	2·60	250
31	......	......	......	......	......	......	2·31	172	......	......

No. 60.

Valley River, at Valley River, for 1913.

July.		August.		September.		October.		
Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Day.
Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	
2·71	204	3·11	445	2·05	123	1·55	66	1
3·01	399	3·21	495	1·88	100	1·54	65	2
3·11	445	2·91	359	1·89	101	1·54	65	3
4·91	1,506	2·91	359	1·89	101	1·52	63	4
8·19	3,480	2·71	283	1·87	99	1·50	62	5
7·87	3,270	2·91	359	2·67	271	1·52	63	6
7·40	3,000	2·81	319	2·42	199	1·50	62	7
6·21	2,280	2·76	298	2·27	164	1·49	61	8
5·61	1,920	2·61	253	2·20	150	1·47	59	9
5·51	1,860	2·51	223	2·12	134	1·54	65	10
6·95	2,130	2·41	197	2·08	126	1·58	68	11
6·61	2,520	2·36	182	1·91	105	1·55	66	12
8·31	3,540	2·31	172	1·11	38	1·60	70	13
8·20	3,480	2·22	154	1·90	104	1·62	72	14
......	2,500	2·22	154	1·90	104	1·69	79	15
5·71	1,980	2·22	154	1·84	96	1·63	73	16
5·31	1,746	2·30	170	1·80	92	1·63	73	17
4·81	1,446	2·21	152	1·79	89	1·63	73	18
4·41	1,206	3·11	445	1·76	86	1·68	78	19
4·11	1,026	3·06	419	1·71	81	1·63	73	20
3·81	846	3·01	399	1·60	70	1·60	70	21
3·56	696	2·99	391	1·55	66	1·71	81	22
3·31	550	2·82	323	1·51	63	1·69	79	23
3·01	399	2·70	280	1·60	70	......	......	24
2·81	319	2·60	250	1·59	69	......	......	25
2·61	253	2·50	220	1·58	68	......	......	26
2·41	197	2·20	150	1·59	69	......	......	27
2·21	152	1·15	40	1·59	69	......	......	28
2·01	119	2·43	201	1·60	70	......	......	29
1·81	93	2·22	154	1·60	70	......	......	30
1·61	71	2·15	137	......	......	......	......	31

Mossy River.

A.—LOCATION.

The Mossy river, which rises in lake Dauphin, and is some 21 miles in length, discharges into the southerly end of lake Winnipegosis.

B.—GENERAL DIRECTION.

Heading in the extreme northerly portion of lake Dauphin, the river flows in a westerly course for a distance of two miles. It then bends in a northerly direction, retaining this latter course to the mouth.

C.—RIVER BASIN.

With the exception of the Fork and Fishing rivers, which enter the Mossy from the west, the drainage of the basin is collected by lake Dauphin. Discharging into this lake are the Valley, Turtle, Ochre, Wilson and Vermilion rivers. These rivers, which head in many small lakes and muskegs in the Riding and Duck mountains, flow in a general easterly course to the lake. The upper watershed in the mountains comprises a hilly or rolling country which is well timbered, while the lower and greater portion of the basin is undulating prairie, covered in many places with a growth of willows. In this prairie section, which is very fertile, grain growing and mixed farming are carried on extensively.

D.—NATURE OF BANKS.

The banks of the Mossy vary in height from four to fourteen feet, and are composed of blue or yellow clay overlying a bed of fine gravel. Approximately, 1½ miles above lake Winnipegosis, an outcrop of limestone crosses the bed of the river. Here for a distance of 100 feet along the left bank, a vertical face of rock extends some 6 feet above ordinary stages of river level. Below this outcrop, in the vicinity of the mouth of the river, the banks become low and marshy. At various points along the river, dredged material from the river bed has been dumped along shore, giving an irregular bank.

E.—WIDTH OF RIVER AND NATURE OF BED.

The Mossy river varies in width from 120 to 200 feet, with an average of 160 feet. The bed of the stream is composed of sand and gravel, with numerous boulders occurring in certain localities. The channel has been improved by dredging and by the removal of boulders, practically eliminating all rapids. Due to sand bars, very shallow water occurs at the entrance to the river at lake Dauphin and also at the mouth of the Winnipegosis.

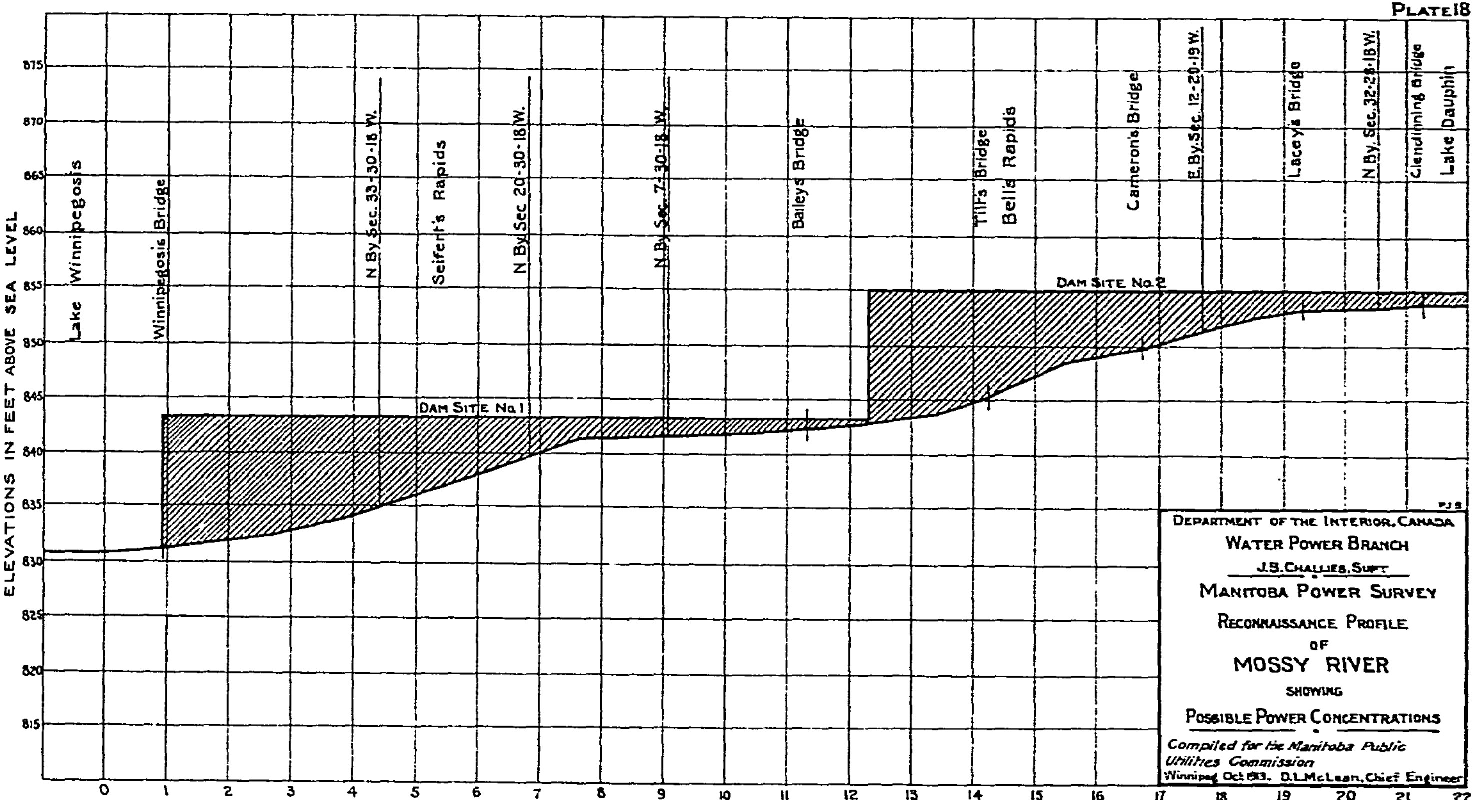
F.—TIMBER AND VEGETATION.

To the west of the Mossy, the land is well settled, and fertile fields devoted to the growth of wheat, oats, barley and root crops border on the river. Farming is not carried on to the same extent east of the river, the greater portion of the land being covered with a growth of willows and poplar.

G.—HIGH AND LOW WATER.

High water usually occurs in April and early May at the time of the spring breakup. Heavy rains in the head-waters also give rise to high water during later periods of the year. It is stated that in the year 1902 extreme high water occurred, being

PLATE 18



Douglas L. McLean Chief Engineer
[illegible] Asst Chief Engineer

some six feet higher than the ordinary stages of the river level. In July, 1913, the water was again high, due to prolonged heavy rains, but did not reach within 4 feet of the extreme of 1902. Low water usually occurs in February.

H.—ICE CONDITIONS.

It is stated locally that for the first three miles below lake Dauphin the river does not freeze over in winter, but lower down the surface freezes, in some places to a depth of two feet or more. It is also reported that since the improvements to the river channel, the ice breaks up in the spring without the formation of ice jams.

I.—ACCESSIBILITY AND NAVIGATION.

Winnipegosis, the terminus of the Winnipegosis branch of the Canadian Northern railway, is situated at the mouth of the river. Southerly from this town for a distance of 14 miles to Fork river, the railway is never more distant than 1½ miles from the river. Some six bridges, which are accessible by numerous roads, cross the river at various points. The stream itself is navigable for small crafts, but is not now used for transportation.

J.—SETTLEMENTS.

As stated previously, the adjacent country is a well-settled agricultural district. The town of Winnipegosis, which has a population of some six hundred people, is situated at the mouth of the river, while the town of Dauphin, which is the central point of the district, is only some 40 miles distant therefrom.

K.—SURVEYS.

A geological reconnaissance of the river and tributary country was made in the year 1889 by the Dominion Geological Survey. During the years 1887 to 1898, the country was subdivided by Dominion Land Survey, and opened up for settlement. With a view to lowering lake Dauphin by dredging the river channel, the Dominion Department of Public Works made a survey of the river in 1908 and, in the four following years, dredging was proceeded with. In 1905, D. A. Keizer, C.E., surveyed and reported on a possible power site situated one-half mile above the town of Winnipegosis. During the summer of 1913, a reconnaissance investigation of the power possibilities of the river was made by a field party of the Manitoba Power Survey.

L.—RUN-OFF.

(a) *Precipitation.*—Although no records of precipitation of sufficient period are available for the district, it is estimated that the mean annual rainfall is approximately 18 inches, the estimate being based on records in adjoining drainage basins of practically the same physical features.

(b) *Discharge Measurements.*—On July 14, 1913, a gauging station was established on the river one-half mile below the entrance of the Fishing river. Results of meterings taken at this section, together with an estimate of daily discharge from July 14, 1913, are given in tables No. 61 and No. 62.

M.—STORAGE POSSIBILITIES.

Lake Dauphin, with an area of 196 square miles, is practically the collecting basin of all drainage carried by the Mossy. Preliminary investigations indicate that it would be possible to obtain a 3-foot storage on this lake. At the same time it would be

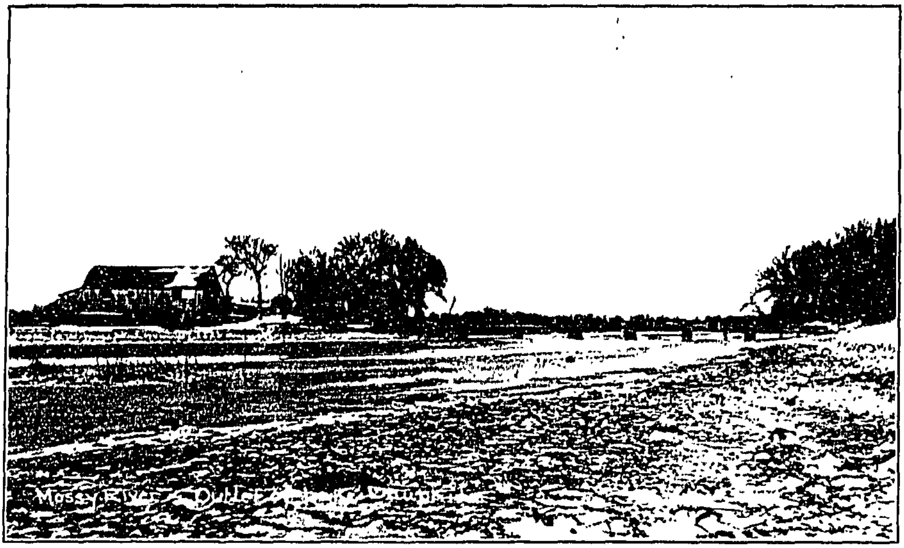
necessary to consider the effect of any such storage on certain low-lying lands bordering on the lake. The dredging and improvements to the river channel during past years were carried on with the object of lowering the level of lake Dauphin and giving better drainage to such low lands. While the effects of possible drainage are not dealt with in this report, the following table gives an estimate of the flow available from storage on the lake, under the following headings: (*a*) The capacity of reservoir per foot depth of storage; (*b*) the rate of draft available for a storage extending over a period of six months; (*c*) the rate of draft available for a storage extending over one year:—

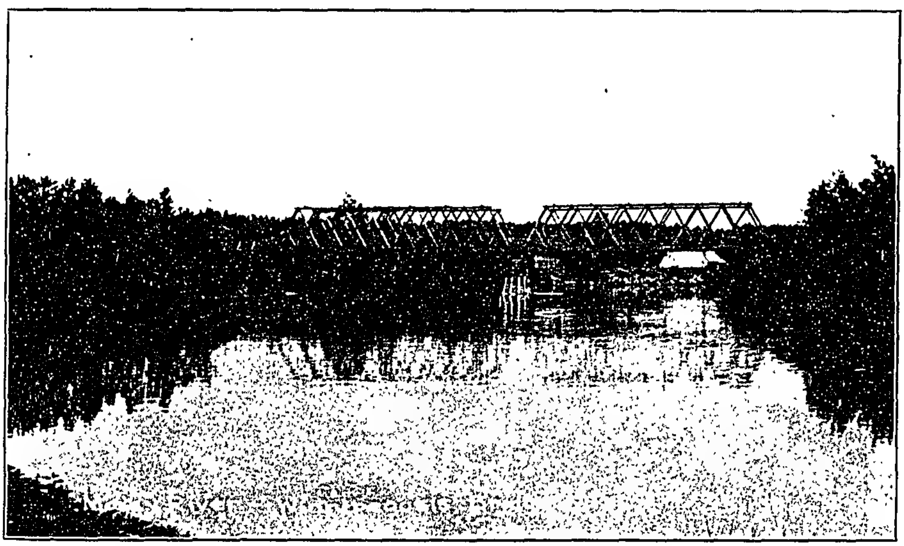
Depth of Storage.	Storage in millions of cu. ft.	Flow in cu. ft. per second.	
		Period 6 mos.	Period 1 year.
	(*a*)	(*b*)	(*c*)
1 foot..	5464	346	173
2 "	10928	692	346

X.—POWER POSSIBILITIES.

While the records of stream measurements for this river do not at present extend over sufficient period to define the minimum flow, it is estimated that the minimum flow is approximately 500 second-feet, this estimate being based on gauge records obtained during the winter of 1911-12 by the Department of Public Works, at a point approximately one mile upstream from the Manitoba Hydrographic gauging station. Using this amount, which is subject to verification or revision as future records are obtained, the following table gives the estimated available horse-power at two possible power sites as shown on profile plate No. 18. In the results, as given, the power has been based on an 80 per cent turbine efficiency. No estimate is made as to the additional power available through a regulation of the flow of the river, although the same would greatly increase the power possibilities:—

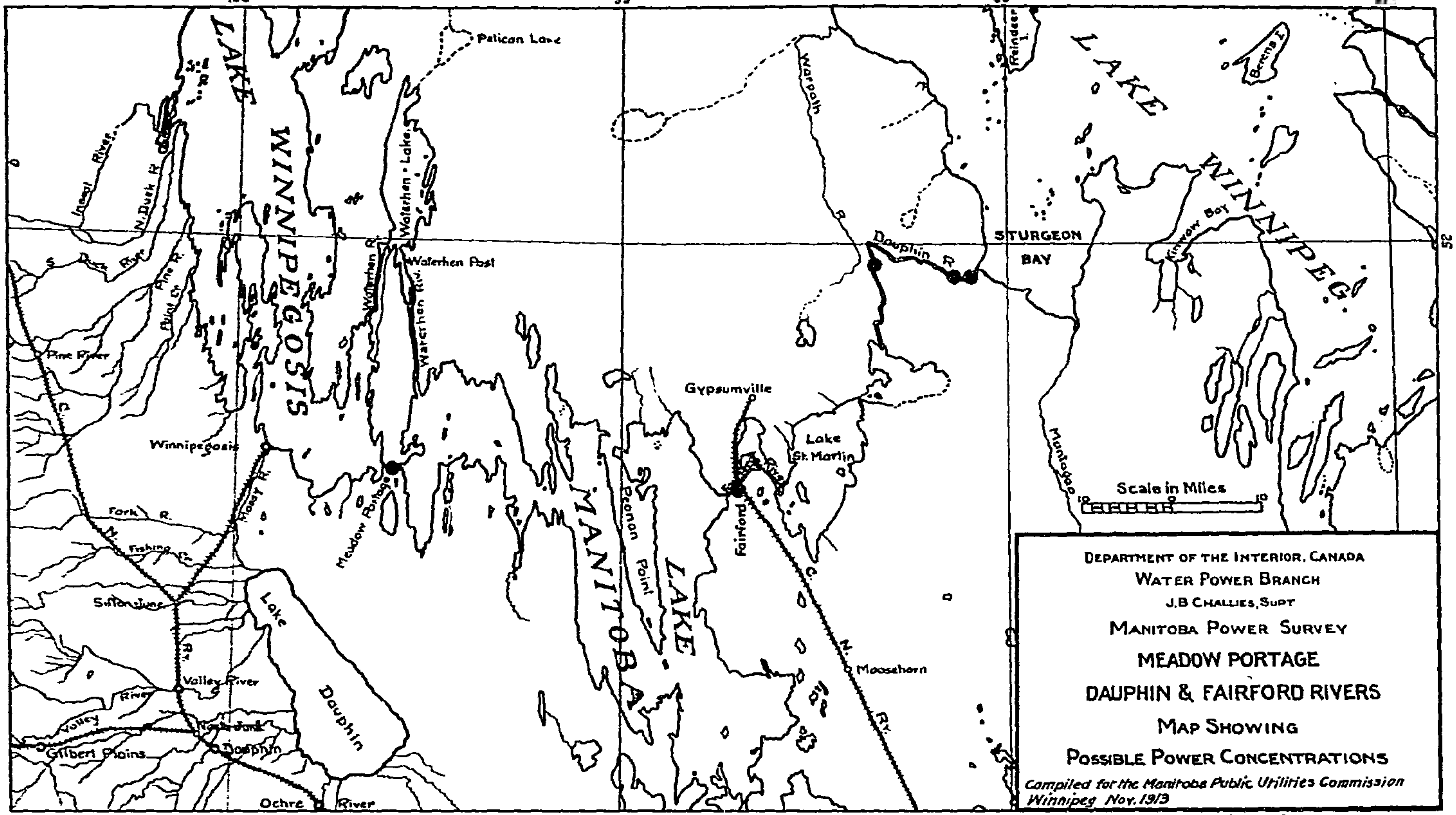
Power Site.	Head.	Estimated Horse-power, based on 80 per cent efficiency and a minimum flow of 500 second-feet.
No. 1....................	10	455
No. 2...	10	455
Total horse power.....	....	910


Mossy River



Mossy River. Bell's Rapids
From above
Aug. 18th. 1913.

PLATE 19



Douglas L. McLean ... Chief Engineer
Stuart S. Scovil ... Asst. Chief Engineer

TABLE No. 61.

DISCHARGE MEASUREMENTS of Mossy River, below Fishing River (Lacey's), 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean Velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
July 14	A. Pirie	1496	131·5	591·6	2·80	3·66	1658·1
Aug. 11	D. B. Gow	1187	128·0	485·0	2·64	3·83	1280·4
" 19	D. B. Gow	1187	140·0	651·0	1·83	2·63	1191·3[1]
" 23	W. J. Ireland	1469	115·8	452·3	2·54	2·68	1151·3
Nov. 11	C. O. Allen	1374	103	229	2·31	1·59	666

[1] Metered two miles below regular section.

TABLE No. 62.

DAILY GAUGE HEIGHT AND DISCHARGE, Mossy River, near Fishing River, for 1913.

Day.	July.		August.		September.		October.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	3·20	1435	2·55	1105	2·05	868
2	....	....	3·20	1435	2·53	1095	2·05	868
3	....	....	3·20	1435	2·50	1080	2·03	859
4	....	....	3·30	1490	2·50	1080	1·87	788
5	....	....	3·10	1380	2·50	1080	1·90	800
6	....	....	3·10	1380	2·51	1085	1·90	800
7	....	....	3·00	1330	2·50	1080	1·85	.780
8	....	....	2·90	1280	2·50	1080	1·85	780
9	....	....	2·90	1280	2·30	980	1·86	784
10	....	....	2·50	1080	2·20	935	1·30	560
11	....	....	2·50	1080	2·20	935	1·60	680
12	....	....	2·50	1080	2·21	940	1·65	700
13	....	....	2·50	1080	2·23	949	1·64	696
14	3·70	1710	2·80	1230	2·20	935	1·59	676
15	3·60	1655	2·70	1180	2·20	935	1·63	692
16	3·60	1655	2·70	1180	2·19	931	1·63	692
17	3·50	1600	2.67	1165	2·10	890	1·70	720
18	3·50	1600	2·66	1160	2·15	913	1·70	720
19	3·50	1600	2·68	1170	0·63	329	1·70	720
20	3·40	1545	2·67	1165	1·15	498	1·70	720
21	3·40	1545	2·66	1160	1·90	800	1·65	700
22	3·30	1490	2·67	1165	2·00	845	1·70	720
23	3·30	1490	2·67	1165	2·20	935	1·70	720
24	3.30	1490	2·65	1155	2·20	935	1·70	720
25	3·30	1490	2·65	1155	2.10	890	1·70	720
26	3·30	1490	2·65	1155	2·05	868	1·70	720
27	3·20	1435	2·65	1155	2·07	876	0·90	410
28	3·20	1435	2·63	1145	2·00	845	0·90	410
29	3·40	1545	2·63	1145	2·00	845	1·10	480
30	3·20	1435	2·63	1145	2·00	845	1·10	480
31	3·20	1435	2·50	1080	....	....	1·13	491

WATERHEN RIVER AND MEADOW PORTAGE.

WATERHEN RIVER.

A.—LOCATION.

The Waterhen river, plate No. 10, flows out of lake Winnipegosis at its southerly end, and discharges into the northerly end of lake Manitoba.

B.—GENERAL DIRECTION.

Heading in Long reach of lake Winnipegosis, the river flows in two distinct channels in a northerly direction a distance of some 8 miles, and enters Waterhen lake; passing through this lake the river flows in a southerly direction some 18 miles before emptying into lake Manitoba.

C.—RIVER BASIN.

The drainage basin of the Waterhen river, which has an area of 21,200 square miles at the outlet of lake Winnipegosis, comprises that portion of Manitoba lying between the above lake and the highlands of the Porcupine, Riding and Duck mountains. Westward, from lake Winnipegosis to the mountains, the basin is a slightly undulating plain with a gentle upward slope which, for the most part, has an overlying soil of clay, through which occasional rock outcrops occur. In the vicinity of the mountains the country becomes rugged and rises very abruptly. This upper land in which lie the head-waters of the drainage is, to a great extent, covered with a timber growth of pine and spruce. The main streams tributary to lake Winnipegosis heading in this district are the Red Deer, Swan and Valley rivers. While several large lakes such as lakes Winnipegosis, Red Deer, Swan and Dauphin are situated in the lower portion of the drainage, yet lakes occurring in the head-waters, though numerous are exceedingly small in size.

D.—RIVER CHANNEL.

From lake Winnipegosis to Waterhen lake there are two distinct river channels: a smaller channel heads in the lakes some six miles south of the main river and has a course parallel to the latter with an intervening space varying in width from one-half mile to a mile. At a mile from the source of the main river a cross channel flows from it to the smaller stream. Below this there is no connection between the two rivers until Waterhen lake is reached; from this lake to lake Manitoba the river flows in one channel only.

E.—NATURE OF BANKS.

In both the upper channels the river flows between low marshy banks which extend back some 1,200 feet before the timber line is reached. Where this growth occurs, the banks reach an average elevation of from three to four feet above the ordinary stages of river level. Great portions of the intervening space between river and timber line are covered with water, and growths of reeds extend far out into the river itself. The soil, to a depth of one foot, is light and sandy, but underlying this is a strata of light blue clay mixed with gravel. From Waterhen lake to within a few miles of lake Manitoba, the banks are slightly higher and drier and, from surface indications, are composed of the same soil. In the vicinity of lake Manitoba the banks again become low and marshy.

F.—WIDTH OF RIVER AND NATURE OF THE BED.

The width of the main Waterhen river averages about 600 feet, with the exception of the portion in the vicinity of the lakes where the width increases to approxi-

mately a mile. The smaller channel, or Little Waterhen, has an average width of some 200 feet. The bottom of both rivers is composed of gravel strewn in some places with large boulders which, in the reach of the river below Waterhen lake, make navigation very difficult.

G.—TIMBER AND VEGETATION.

Hay meadow land borders the river for almost its entire length, but very little hay is cut, due to the extreme wetness of the land. Timber is plentiful but consists almost entirely of poplar, with a sprinkling of spruce and birch. At the Waterhen Trading post on Waterhen lake, root crops are grown for local consumption.

H.—RUN-OFF.

(*a*) *Precipitation.*—No definite information relating to precipitation is available for this whole drainage basin. Records at Russell and Minnedosa, which are situated slightly to the south of the drainage basin, show a mean annual precipitation at Russell of 16·4 inches for a period of nine years, and a mean annual precipitation of 17·8 inches at Minnedosa for a period of 32 years. As somewhat similar physical conditions apply both to the upper drainage of the Waterhen and to these two points, it may be assumed that the precipitation is of like amount.

(*b*) *Discharge Measurements.*—In the summer of 1881, a discharge measurement of the Waterhen river was made by Thomas Guerin, C.E. No further measurements appear to have been made until 1913, when a metering was made by the Manitoba Hydrographic Survey at a section below Waterhen lake, showing a discharge of 8474 second-feet, table No. 63. Owing to the inaccessibility of this portion of the river, no regular gauging station has been maintained. In the absence of more reliable data, an estimated low flow of 5,000 second-feet has been based on measurements made on the Fairford river during 1912-13 by the Manitoba Hydrographic Survey. While this estimate is used for computing the power possibilities, it should be borne in mind that the flow given is purely an estimate, and is subject to revision.

I.—MEADOW PORTAGE AND POWER POSSIBILITIES

As a power possibility in itself, the Waterhen river does not offer any very attractive features, but rather by the diversion of its waters across the narrow neck of land separating lake Winnipegosis from lake Manitoba. This strip of land, lying at the southwest corner of the former lake, has, at its narrowest part in the vicinity of Meadow Portage, a width of some 9,400 feet. The summit elevation is approximately six feet above lake Winnipegosis, and the surface soil is composed of a light grey calcareous clay, holding many pebbles of limestone. From investigations made at the summit, hard-pan occurs at a depth of four feet, while adjacent to the lakes clay constitutes the underlying soil.

At various times the construction of a canal between the two lakes has been advocated for navigation purposes and, were this undertaking proceeded with, the development of power in conjunction with the canal would be an important factor.

J.—TRANSPORTATION AND ACCESSIBILITY.

The Waterhen river and Mossy Portage are both accessible in summer by boat from the town of Winnipegosis, which is situated at the southern end of lake Winnipegosis. The distance from this latter place by water is some 22 miles to the river and 15 miles to the portage. A wagon road also leads from the town to the portage. The Waterhen river is navigable for boats of shallow draught, but, below Waterhen lake, navigation is difficult, due to boulders in the river bed and to submerged vegetation.

K.—SETTLEMENTS.

Outside the Waterhen Indian Reserve, which lies to the north of Meadow Portage, and between the upper and lower branches of the Waterhen, no settlements of any size are situated in the immediate vicinity. Land surrounding the Meadow Portage has been subdivided and is partially settled.

L.—SURVEYS OF WATERHEN RIVER AND MEADOW PORTAGE.

The country in the vicinity of Meadow Portage has been subdivided by Dominion Land Survey. In 1889 the Geological Survey of Canada made a geological survey of the district, including the Waterhen river. A survey of Meadow Portage was made slightly previous to the year 1909 by the Dominion Department of Public Works, while in the year 1909 further investigations were carried on by the same department. In the summer of 1913 a reconnaissance survey of Meadow Portage was made by the Manitoba Power Survey, with Mr. D. B. Gow in charge of the field party. At the same time, investigations were made as to the location of dam sites on the upper Waterhen rivers, as it would be necessary to divert the waters from this outlet for any complete development in the vicinity of Meadow Portage.

M.—HEAD AVAILABLE.

The difference in elevation between the two lakes on August 26, 1913, as determined by the Manitoba Power Survey, was 18·6 feet. The water in both lakes at the time was stated locally to be at a high stage. As published in the Geological Survey Report of 1889-91, the difference in elevation in 1873 was found by Mr. H. B. Smith, C. E., to be 18·73 feet, and later, in 1889, a determination of 17·4 feet was made by G. A. Bayre, C.E.

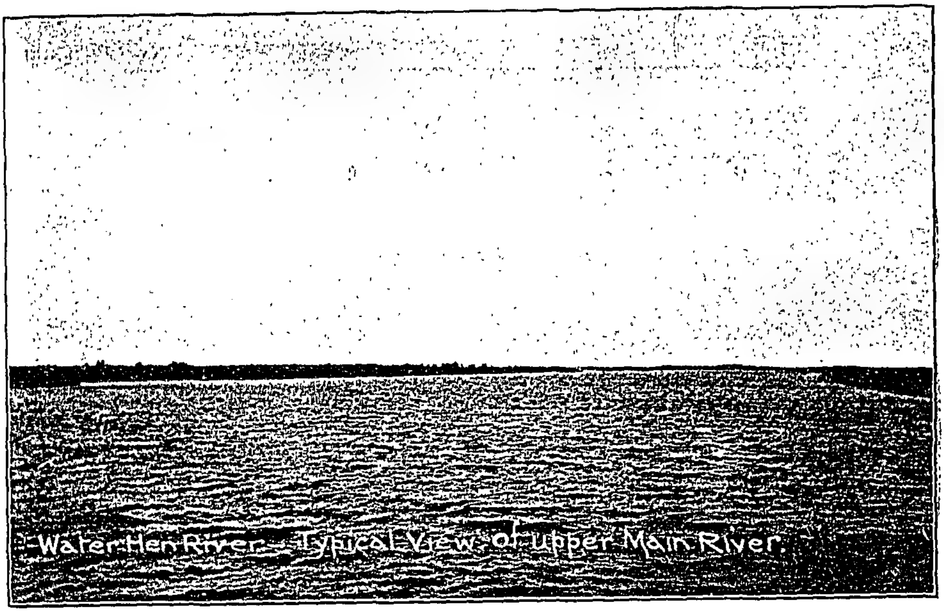
Due to storms on the lakes, considerable variation in this drop is quite probable. It is stated that a severe storm from the northwest is capable of raising the waters at the southerly end of the lake Winnipegosis to an extent of three feet. Evidences of such an effect were noted, after a severe storm, by the Manitoba Power Survey. At the same time, a lowering of the northern waters of lake Manitoba occurs, but of a decidedly smaller range than in the upper lake.

N.—WATER-POWER.

As stated previously, a low flow of 5,000 second-feet has been assumed for the Waterhen river. This, together with an approximate head of 15 feet (both of which figures are subject to revision) would, on a basis of 80 per cent efficiency, show a power possibility of 6,807 horse-power.

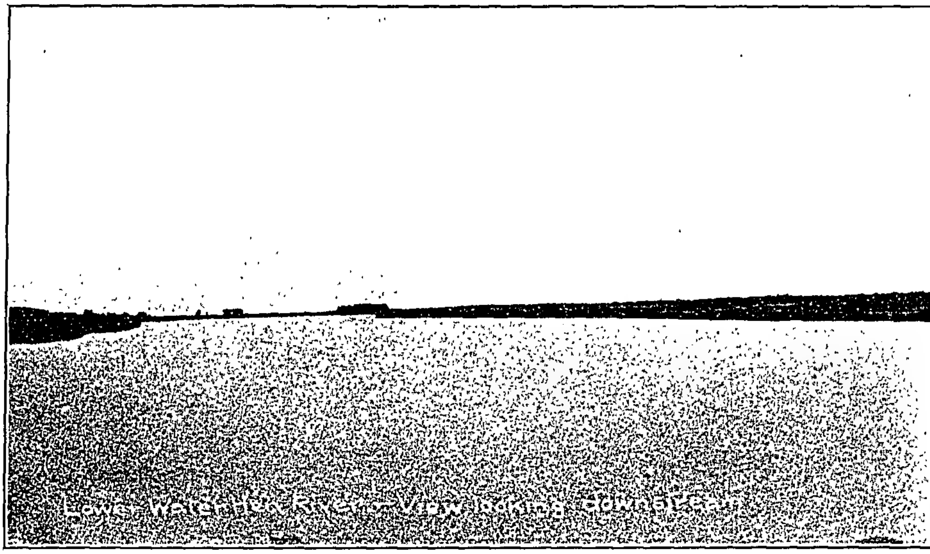
O.—STORAGE POSSIBILITIES.

Lake Winnipegosis, which acts as the collecting basin for the entire drainage area, offers immense storage possibilities. It has an area, exclusive of islands, of some 2,000 square miles. While storage would be possible on this lake, the effect of any raising of the waters would have to be considered with reference to any low-lying areas bordering on the lake. The following table has been computed in order to show the possibilities of additional flow and power from such storage under the following headings: (a) the flow in cubic feet per second for a storage utilized in a period of six months; (b) the power available from this flow based on a 15 foot head at 80 per

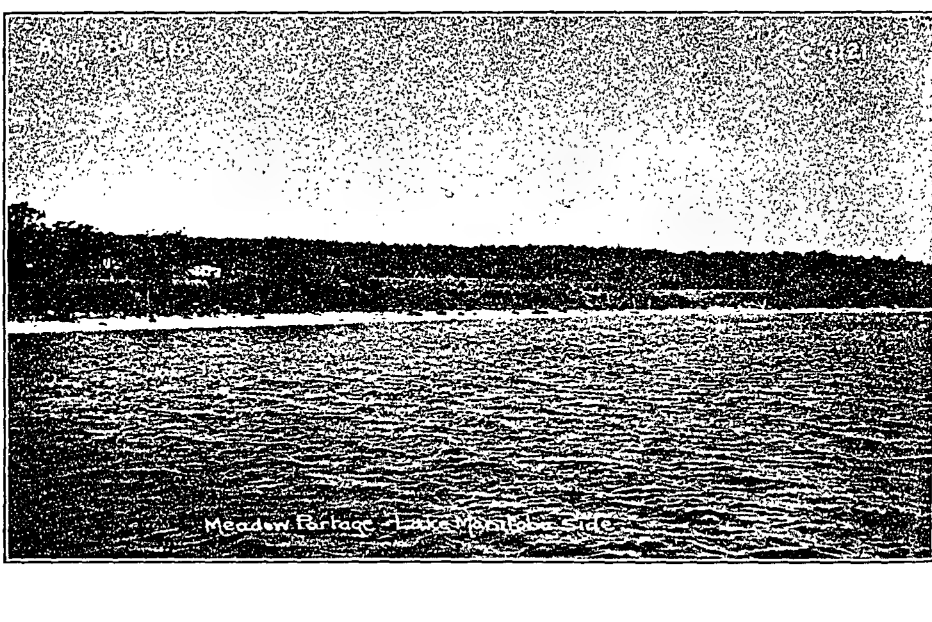


Water Hen River — Typical View of upper Main River.

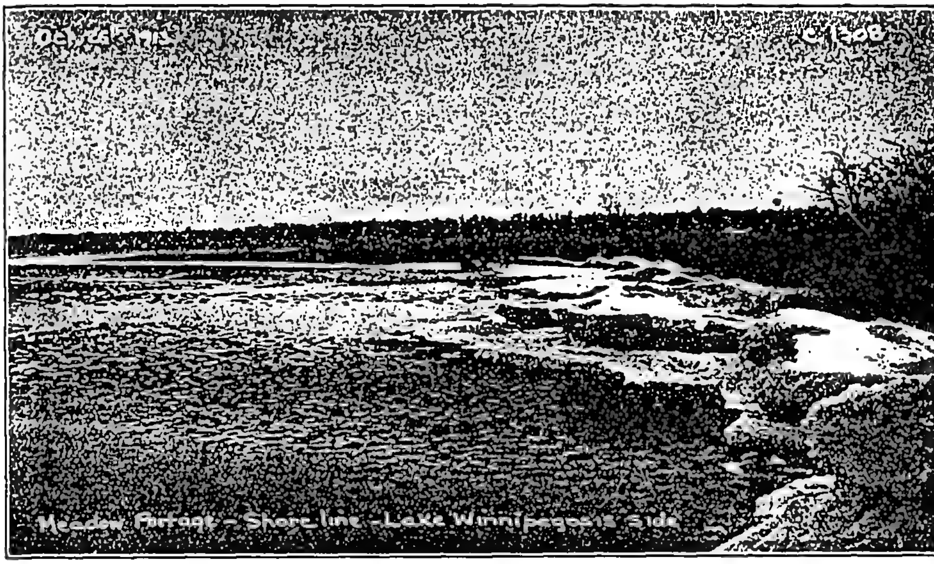
Little Waterhen River — Typical view of Water channel.



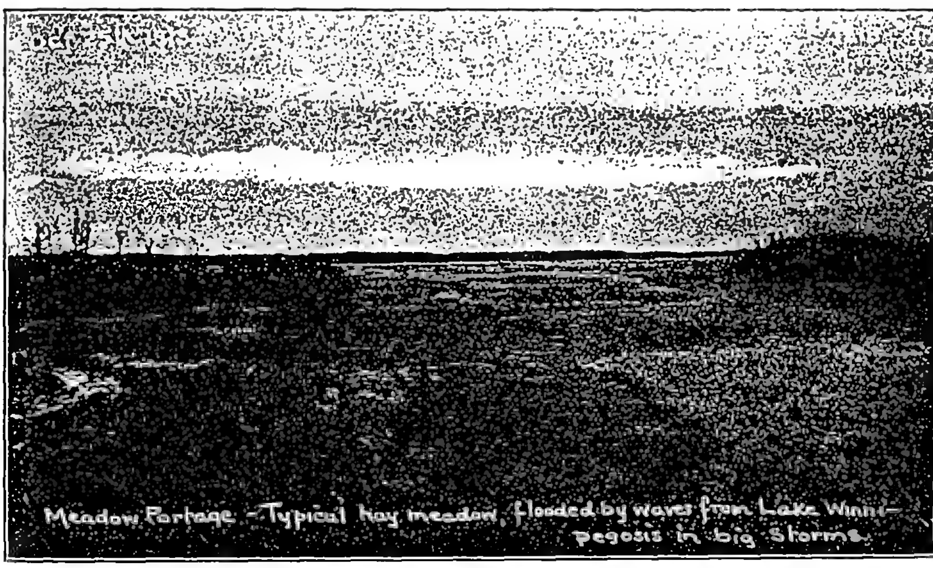
Lower Waterhen River - View looking downstream



Meadow Portage - Lake Manitoba Side



Meadow Portage – Shore line – Lake Winnipegosis side



Meadow Portage – Typical hay meadow, flooded by waves from Lake Winnipegosis in big Storms.

cent efficiency; (*c*) the flow in cubic feet per second for a storage utilized in a period of a year; (*d*) the power available based on the same conditions as in (*b*).

Depth of Storage in Feet.	Flow in Sec.-ft. for 6 months.	Horse-power.	Flow in Sec.-ft., 1 year.	Horse-power.
	(*a*)	(*b*)	(*c*)	(*d*)
1...........	3,536	4,814	1,768	2,407
2.............................. ...	7,072	9,628	3,536	4,814

TABLE No. 63.

DISCHARGE MEASUREMENT of Waterhen River, four miles from Lake Manitoba, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge
1913.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft,
Aug. 22..	D. B. Gow	1187	439	3038	279	....	8474

FAIRFORD AND DAUPHIN RIVERS.

A.—LOCATION AND GENERAL DIRECTION.

The Fairford and Dauphin rivers (*see* plate No. 19), form the connection between lake Manitoba and lake Winnipeg. Heading in lake Manitoba at almost the extreme northeasterly corner, the Fairford river flows in a northeasterly direction and enters the westerly end of lake St. Martin. This latter lake is discharged by the Dauphin river which heads in the northeast corner of the lake, and flows almost due north for a distance of 14 miles. A sharp bend to the east then occurs in the river and this latter course is held throughout to the mouth, which enters Sturgeon bay on the west shore of lake Winnipeg.

B.—RIVER BASIN.

Lake Manitoba, with an area of 1,711 square miles, acts as a collecting basin for practically all the drainage carried by this system of rivers. In general terms, the area drained is that land lying to the east of the Manitoba escarpment, together with those portions of the plains tributary to the Swan and Red Deer rivers. While the upper reaches of the watershed extend into the Riding, Duck and Porcupine mountains, where the country is hilly and to a great extent covered by a forest growth, yet the greater portion of the area is a slightly undulating prairie. The soil for the most part is an agricultural clay overlying beds of gravel, with occasional rock outcrops. Numerous lakes occurring in the drainage vary in size from mere ponds to lakes of great extent, such as lakes Winnipegosis and Manitoba. In the mountain district, the lakes, though numerous, are small in size. In the central portion of the basin three larger lakes occur, lake Dauphin with an area of 196 square miles, Swan lake with an area of 121 square miles, and Red Deer lake of some 100 square miles. These latter lakes, together with many streams, empty into lake Winnipegosis which has an area of 2,000 square miles. The Waterhen river, forming the connecting link in the drainage system between lake Winnipegosis and lake Manitoba, flows in a 'V' shaped

course across a narrow neck of land separating these two lakes. While considerable adjacent territory drains into lake Manitoba, yet the only other tributary of any size is the Whitemud river. From the outlet of the lake to the mouth of the Dauphin river in Sturgeon bay, no streams of any extent are tributary to the river system.

C.—NATURE OF BANKS.

For the first three miles the banks of the Fairford river are well defined, varying from 3 to 10 feet in height, reaching a maximum in the immediate vicinity of the C.N.R. bridge at Fairford station. Below this point the banks become gradually lower, opening out into a wide expanse of low marshy land, which merges into a stretch of water known as lake Pinemuta. After leaving this lake, the banks range from 2 to 3 feet in height, but again merge into swampy shores as lake St. Martin is approached. Throughout, the banks are composed of light grey clay, in which a few boulders are imbedded. Where the Dauphin river leaves lake St. Martin, the banks are poorly defined, low-lying meadows, subject to overflow in periods of high water, merge into the timber line about one-half mile from the other side of the channel. The banks, which are composed of sandy clay and which vary in height from one-half foot to two feet, present this same general appearance for the first 11 miles of river; at this distance from the lake, the river cuts through a sandy ridge running in an east-and-west direction, and of a maximum height of some 8 feet. For the following 12 miles, to a point on the river where rapids occur, the banks become higher, ranging from 1 to 6 feet in height, though in many places giving way to swampy indentations. From the rapids to Sturgeon bay there is a range of from 5 to 32 feet. At numerous places in this lower reach, limestone ridges cross the bed of the river, and rock outcrops are visible in the sandy soil of the banks.

D.—WIDTH OF RIVER AND NATURE OF BOTTOM.

The Fairford river varies in width from 500 to 900 feet. It is stated that the river is shallow in the vicinity of lake Manitoba, where it flows over a bed of limestone. About one-half mile below this a small rapids is caused by a bed of limestone and gneiss boulders; this same feature is also noticeable in the lower portion of the river.

The Dauphin river, which has an average width of 450 feet, is in places slightly narower than the Fairford. The river bed for the first 11 miles is sandy and seemingly free from large boulders, but below this gravel bars and boulder-strewn bottom are encountered, both of which give rise to numerous rapids. Outcroppings of limestone are also found in this lower reach of the river.

E.—TIMBER AND VEGETATION.

The Fairford Indian reserve borders on the Fairford river, and the banks for a short distance in the immediate vicinity have been cleared of timber. Beyond this is a thick growth of poplar.

Along the Dauphin river the greater portion of the land is covered with a dense growth of poplar, spruce, maple, oak and birch, yet at the same time large areas of low-lying swamp land and hay meadows are scattered throughout the course of the river. With the exception of some fields devoted to root crops along the Fairford river, farming is not carried on to any extent in this district.

F.—HIGH AND LOW WATER.

High water usually comes in the latter part of April and the early part of May, while February is the month of low water. The range in river level between these

two periods is ordinarily some 4 feet. An extreme range of some 8 feet was noted in the year 1902.

G.—ICE CONDITIONS.

It is stated that for the first three miles, the Fairford river does not freeze over in winter, but below this an ice cover forms. The statement is also made that during the spring break-up on the Fairford the ice passes away freely without formations of jams or of destruction to the banks, while severe jams do occur on the Dauphin river at the rapids near Sturgeon bay. It is claimed that the jams at this point have caused a rise of from 15 to 20 feet above ordinary summer stages. Evidence of such an occurrence was noted by a field party of the Manitoba Power Survey, boulders, logs and driftwood being found fully 20 feet above the water level of September, 1913.

H.—TRANSPORTATION AND ACCESSIBILITY.

The Fairford river is navigable for small steamers, though it is claimed that difficulty occurs near lake Manitoba, due to bars.

Navigation on the Dauphin river is also possible for small steamers in early summer, but according to local information the river is treacherous, due to continual change of channel. The only point at which the river system is accessible by railroad is at Fairford, where the C. N. Ry. have a bridge spanning the river.

While no railroad lies in the immediate vicinity of the Dauphin river, yet steamers plying on lake Winnipeg navigate to the mouth of the river in Sturgeon bay.

I.—SETTLEMENTS.

Outside of the settlements in the Indian reserve, only two settlements are located in the district, one of those being at Fairford, which is one-half mile from the C.N.R. crossing of the Fairford river, and the other settlement is at Sturgon bay. At this latter place a fish hatchery was constructed by the Department of Marine and Fisheries during the year 1913.

J.—SURVEYS.

A geological reconnaissance was made of the rivers in 1889 and 1890 by the Geological Survey of Canada. Surveys at the Indian reserve on the Fairford river have also been made by the Department of Indian Affairs.

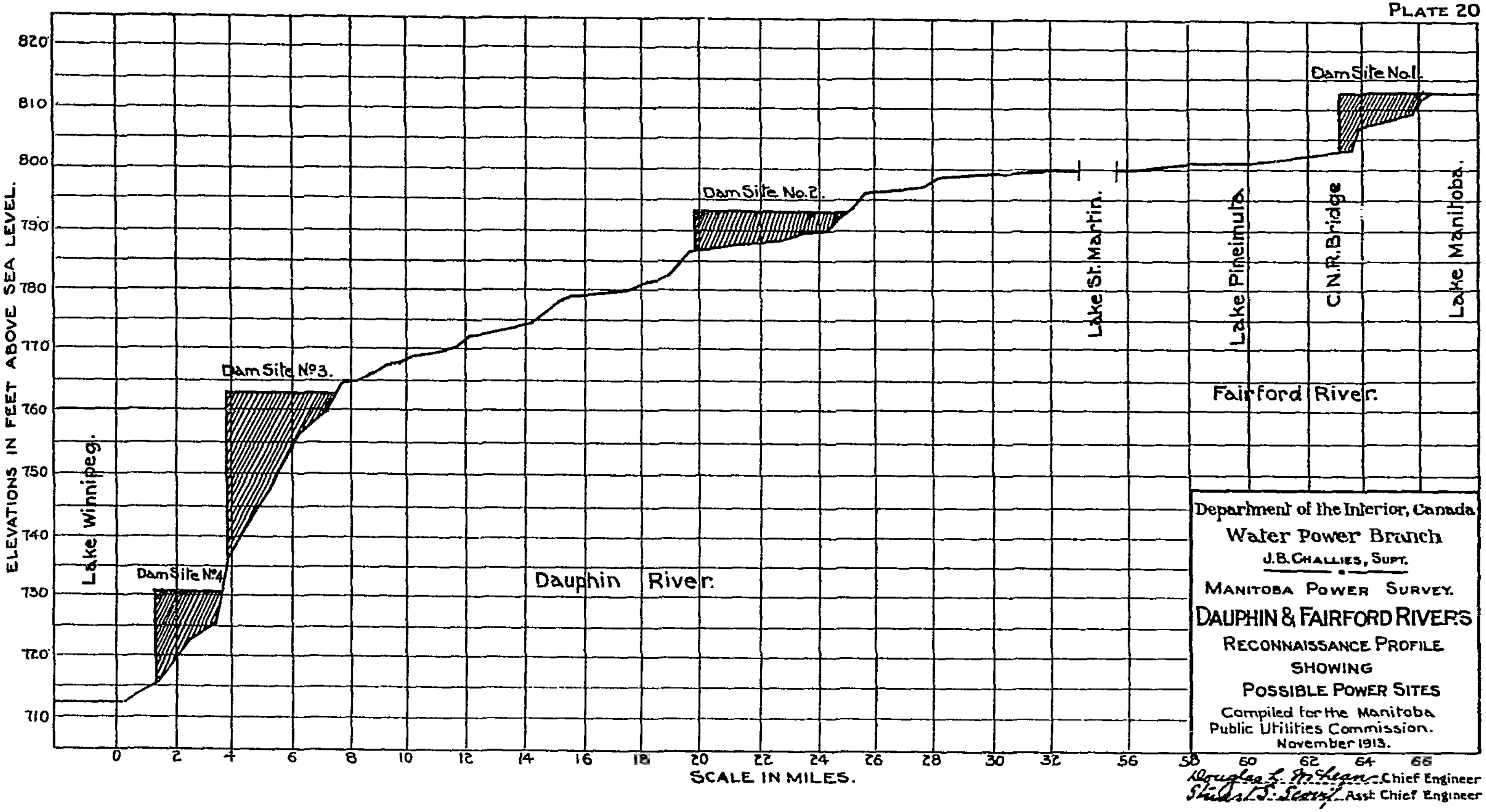
In order to secure data for the improvement of navigation on the Fairford river, surveys extending over the years 1898, 1908, 1910 and 1913 have been made by the Dominion Department of Public Works. In September and October, 1913, a reconnaissance survey of the power possibilities of the river system was made by a field party of the Manitoba Power Survey operating under the direction of the Water-power Branch of the Department of the Interior. A profile of the river, together with investigations of possible power concentrations, were made by this party.

K.—RUN-OFF.

(*a*) *Rainfall.*—Rainfall in this drainage basin is estimated to be a mean of some 18 or 19 inches per annum. Records of very short term have been made of some few places in the district, and on these the above estimate has been based.

(*b*) *Discharge Measurements.*—Discharge measurements by the Manitoba Hydrographic Survey have been made since June 28, 1912, at the C.N.R. bridge crossing

PLATE 20



ELEVATIONS IN FEET ABOVE SEA LEVEL.
820
810
800
790
780
770
760
750
740
730
720
710
Lake Winnipeg.
Dam Site No.4.
Dam Site No.3.
Dauphin River.
Dam Site No.2.
Lake St. Martin.
Lake Pineimuta.
C.N.R. Bridge
Dam Site No.1.
Lake Manitoba.
Fairford River.
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 56 58 60 62 64 66
SCALE IN MILES.
Department of the Interior, Canada
Water Power Branch
J.B. CHALLIES, SUPT.
MANITOBA POWER SURVEY.
DAUPHIN & FAIRFORD RIVERS
RECONNAISSANCE PROFILE
SHOWING
POSSIBLE POWER SITES
Compiled for the Manitoba
Public Utilities Commission.
November 1913.
Chief Engineer
Asst Chief Engineer

the Fairford river near Fairford post office, the results of these measurements being given in table No. 64. Due to changes in the river channel, such as the building of coffer dams and piers at the above bridge, a regular station could not be established, as the above obstructions caused such extreme ranges in gauge heights that no rating of the station was possible. The bridge was completed in the fall of 1913, and on October 30 a gauging station was established. Data is now being obtained so that a complete record of the daily flow from this latter data will be available.

From the results of the above measurements, low flow of 5,000 second-feet has been estimated for the winter of 1912-13. While this flow is being used for the computation of possible power, yet it should be borne in mind that, being an estimate, it is subject to revision when more complete data are obtained.

L.—STORAGE POSSIBILITIES.

Containing, as it does, an immense lake area in the lower reaches of the watershed. it should be possible to obtain practically a complete regulation of the flow. An estimate of the storage possibilities on lake Winnipegosis, and the resulting increase in flow during low periods, has already been made in chapter VIII, with relation to the Waterhen river and Meadow Portage.

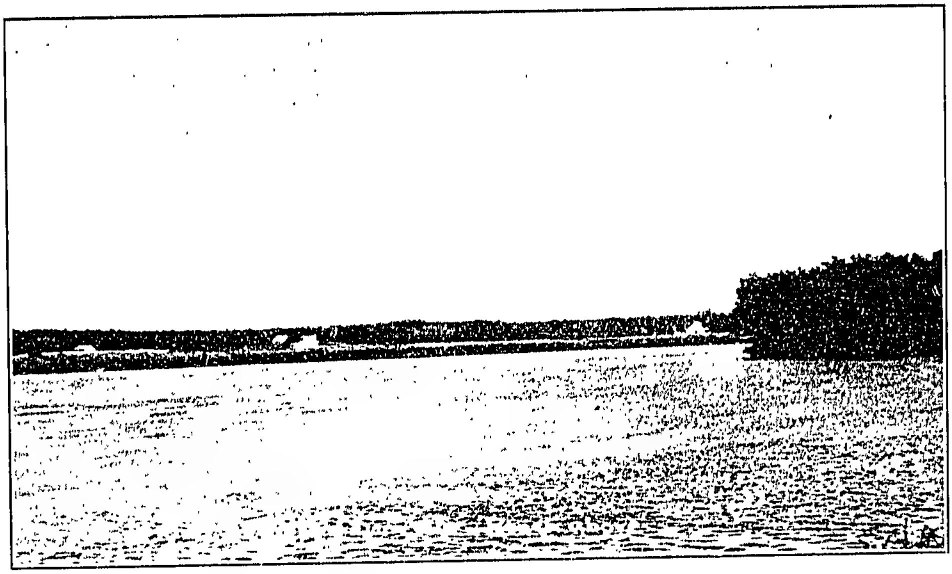
Lake Manitoba is said to ordinarily vary one foot above and one foot below its mean level, giving in all a range of two feet. Assuming that such a range for storage purposes could be utilized, the following table gives the various rates of draft available from such a storage completely used in a period of either 3 months, 6 months, or a year:—

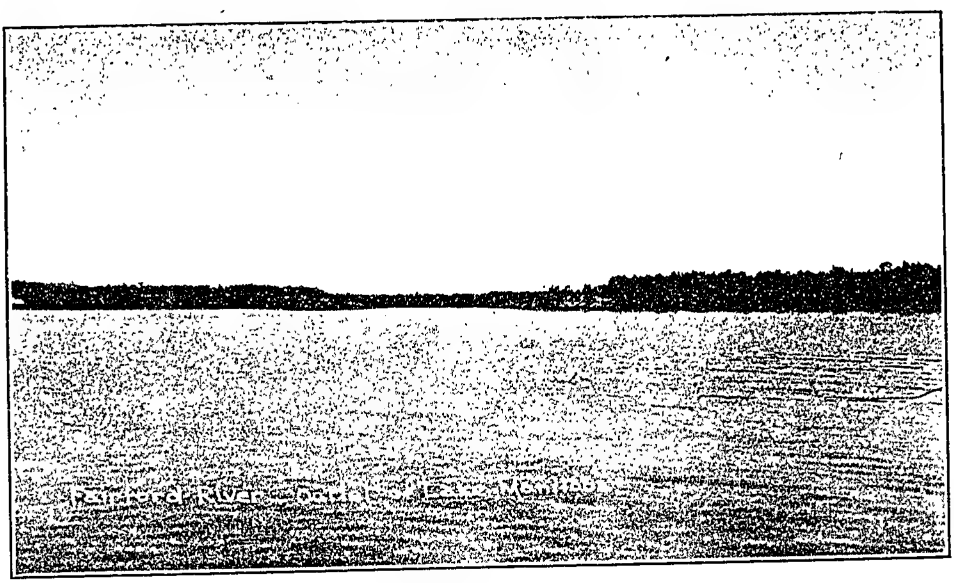
Depth of Storage.	Storage in Millions of cu. ft.	Rate of Draft in Second-Feet.		
		Period 3 Months.	Period 6 Months.	Period 1 Year.
1 foot	47·7	6048	3024	1512
2 "	95·4	12096	6048	3024

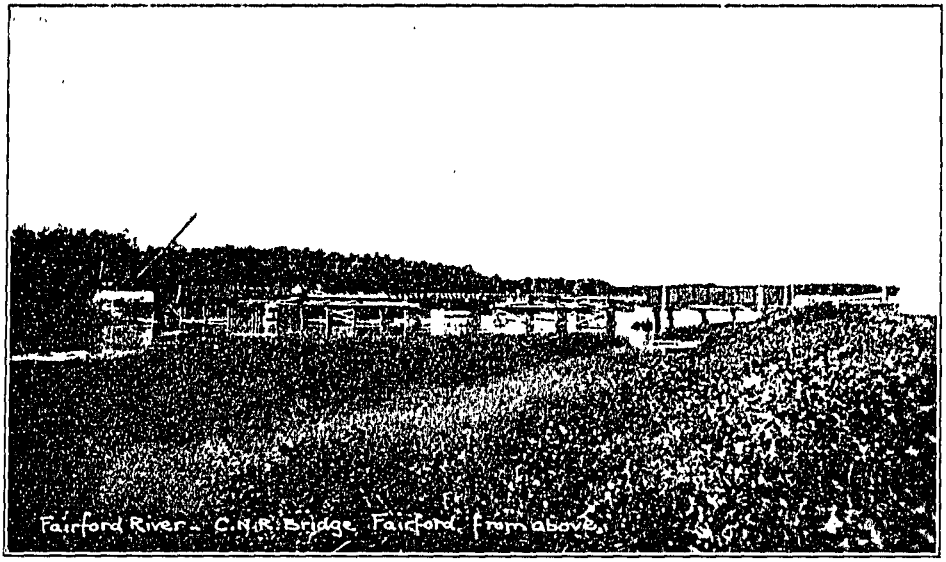
M.—WATER-POWER.

Possible power concentration on the rivers are shown on the profile on plate No. 20. An estimate of the power available at these sites is given in the following table. The power has been computed at 80 per cent efficiency on an estimated low flow of 5,000 second-feet, no estimate having been made as to the additional power available through storage:—

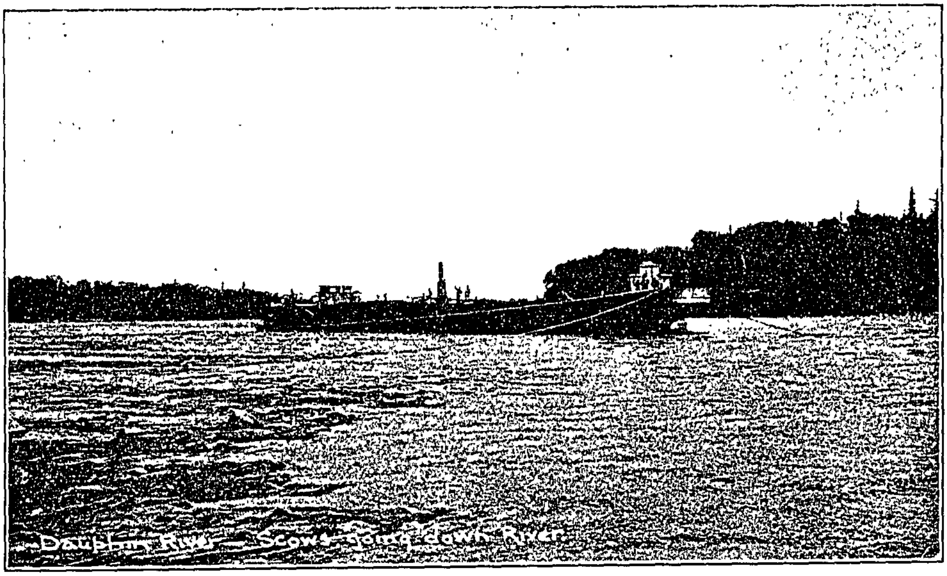
Power Site.	Head in Feet.	Estimated Horse-power at 80 per cent Efficiency, Low Flow of 5,000 Second-feet.
No. 1....................	8	36330
No. 2....................	6·5	2950
No. 3....................	28	12706
No. 4....................	16	7260
Total horse-power....	....	26546





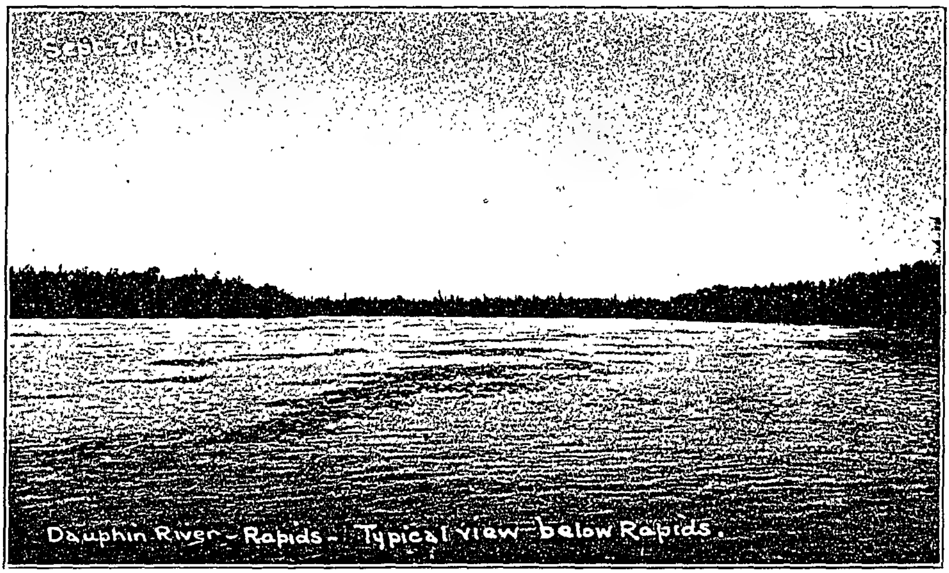


Fairford River – C.N.R. Bridge Fairford, from above.



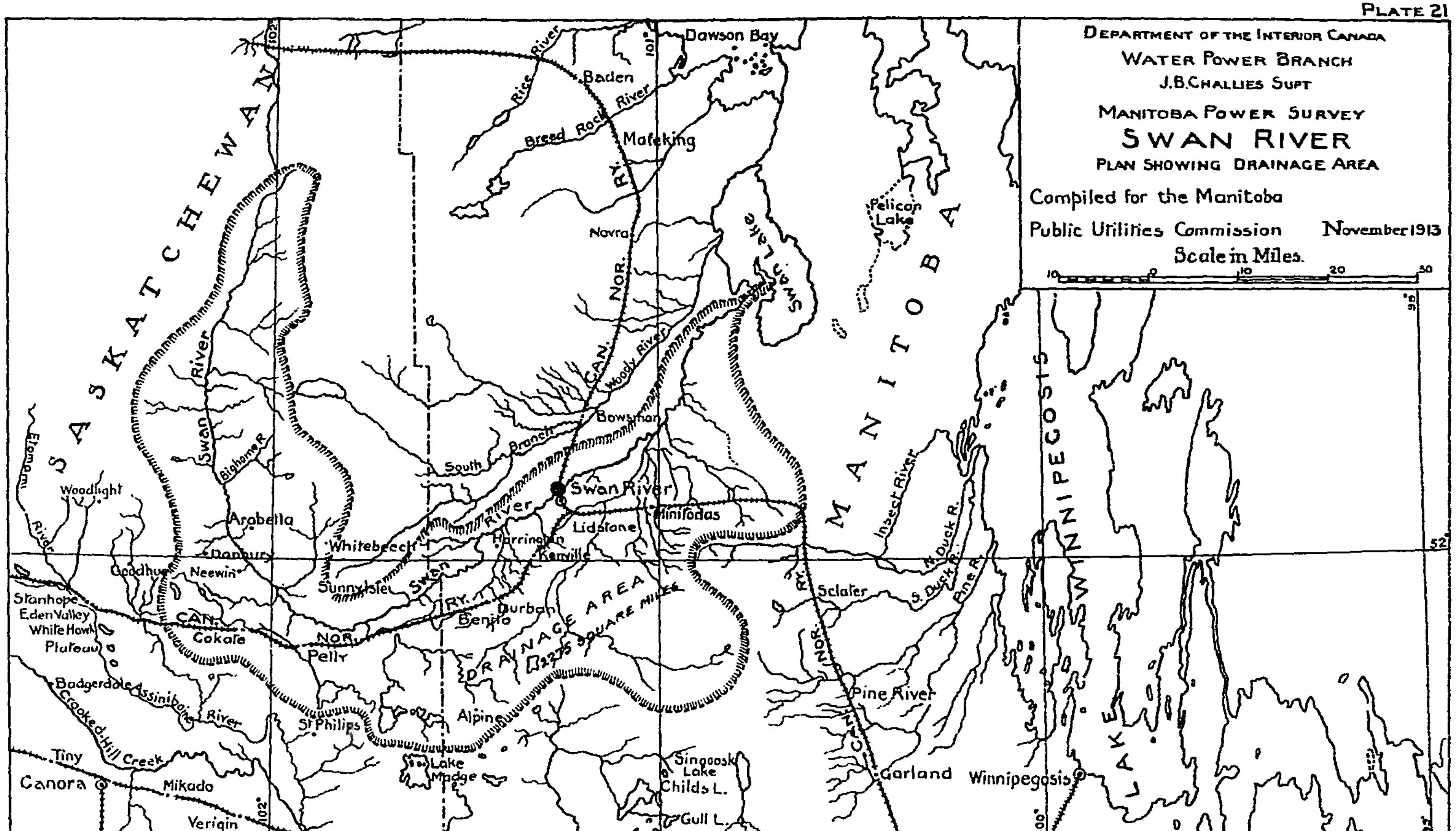
Dauphin River — Scows going down River

Dauphin River – Rapids – Exit to Sturgeon Bay.



Dauphin River – Rapids – Typical view below Rapids.

PLATE 21



Douglas L. McLean Chief Engineer
Stuart B. Scott Asst. Chief Engineer

TABLE No. 64.

DISCHARGE MEASUREMENTS of Fairford River, at Fairford, 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge
			Feet.	Sq. ft.	Ft per sec	Feet.	Sec.-ft.
June 28..	G. H. Burnham	1187	293	1919	4·08	7·82	7849
July 31..	G. H. Burnham	1187	269	1716	4·01	7·48	6897
Aug. 29..	Alex. Pirie	1197	279	1720	4·88	7·60	8341
Oct. 11..	R. H. Nelson	1187	280	1616	4·38	7·52	7083
Dec. 6..	G. J. Lamb..	1187	308	1966	4·52	9·60	8886
Apr. 24..	E. Bankson	1469	283	1572	4·68	7·33	7345
May 15..	G. Ebner	1186	320	1647	4·57	7·56	7527
Aug. 14..	C. O. Allen	3	253	1824	4·10	7·50	7475

SWAN RIVER.

A.—LOCATION.

The Swan river (*See* plate No. 21), situated in central western Manitoba, rises to the west of the Porcupine mountain, and, flowing in the valley between the Porcupine and Duck mountains, discharges into Swan lake.

B.—GENERAL DIRECTION.

Heading in township 42 along the second meridian, the river flows in a southerly direction a distance of 50 miles. Here the river bends to the northeast, continuing this latter course to its mouth.

C.—RIVER BASIN.

The Swan river flows in a wide, deep valley, lying between the Duck and Porcupine mountains. In the lower portion of the watershed from Swan lake to the point at which the river loops around the Porcupine mountains, practically all drainage enter from the south. Many small tributaries heading in the Duck mountains enter from that direction. To the north of this portion of the river the drainage area is confined by the Woody river, which has a parallel course to that of the Swan. Above the bend or loop, the basin widens out, with many small tributaries entering from the east and west. Many springs are stated to exist in the vicinity of the river, but the lakes of the basin are both small and few in number.

D.—NATURE OF BED AND BANKS.

The valley and the banks of the river are to a great extent composed of a deposit of alluvial sand or clay. In the upper portion of the valley it is stated that outcroppings of grey clay shale and sandstone occur along the river. The latter has an average width of 150 feet, with banks ranging from ten to fifty feet in height, and a bed reported to be composed of gravel and clay, with the occurrence of boulders at many points.

E.—TIMBER AND VEGETATION.

In many portions of the mountain country there is an overgrowth of timber, while in the Swan River valley the country is more open. On the rich meadow land of this district, grain growing and farming are carried on extensively.

F.—HIGH AND LOW WATER.

The latter part of April is usually the period of high water, while February is the low-water month. In the year 1913, a range of some 4 feet was recorded between the two extremes.

G.—TRANSPORTATION.

Due to many beds of boulders in the river, navigation is impossible. The river is accessible, however, by old trails, and is also crossed by the Canadian Northern railway at the town of Swan River. A branch line of this railway parallels the course of the river for a considerable distance above the town.

H.—SETTLEMENTS.

The country is essentially an agricultural district, and is well settled. The town of Swan River, which is the commercial centre, is the most important settlement, though many smaller settlements occur throughout the district.

I.—SURVEYS OF THE RIVER.

The Geological Survey of Canada made a geological survey of the river and the surrounding territory in the year 1889.

In the year 1909, Messrs. Pratt and Ross, hydraulic engineers, investigated the power possibilities of the river in the vicinity of the town of Swan River, and reported upon a possible power development. A gauging station was later established on the river on October 24, 1912, by the Manitoba Hydropraphic Survey.

J.—RUN-OFF.

(*a*) *Precipitation.*—No complete records of precipitation are available for this basin, but it is estimated that the annual mean is some nineteen inches.

(*b*) *Discharge Measurements.*—Discharge measurements have been made by the Manitoba Hydrographic Survey near the town of Swan River since October 24, 1912, the results of this work being given in table No. 65. As shown by the estimated daily discharges in tables No. 66 and No. 67 the minimum flow for the year 1913 to October 31, was 50 second-feet, while a flood discharge during the same period amounted to 4,800 second-feet.

K.—WATER-POWER.

No field survey has been made of the power possibilities of the river though it is known that considerable fall does occur throughout the extent of the river. At the junction of Snake creek with the Swan river, some 18 miles west of the Manitoba boundary, the elevation of the river bed, as obtained from preliminary lines of the Canadian Pacific railway, is 1,390 feet above sea-level, while Swan lake is at an elevation of 855 feet. This would indicate a drop of 535 feet in an approximate distance of 100 miles of river. In 1909, Messrs. Pratt and Ross reported on a possible power concentration of some 14 feet head in the vicinity of the town of Swan River. Based on the estimates of flow for the year ending October 31, 1913, the fol-


Sept 23rd 1913
C.1077
Swan River
Looking downstream from Metering Station

lowing table gives the power available per foot head at an 80 per cent efficiency, and is computed for a low flow of 50 second-feet, and also for the lowest monthly mean flow (160 second-feet) for the period of 7 months from April to October. In this latter case, the estimated power only relates to the periods as stated above:—

Head in Feet.	Estimated Horse—Power at 80 per cent Efficiency.	
	Minimum Flow, 50 sec.-feet.	Flow 160 sec.-feet. Period, April to Oct.
1	4·5	14·5
10	45	145
20	90	290

TABLE No. 65.

Discharge Measurements of Swan River, at Swan River, Man., 1912-13.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge.
1912.			Feet.	Sq. feet.	Ft. per sec.	Feet.	Sec.-feet.
Oct. 24..	W. G. Worden..	1196	138	404	2·51	2·55	1013
Dec. 11.	G. Lamb........	1187	101	177	·72	1·43	125[1]
1913.							
Feb. 12.	A. Pirie....	1469	105	54	1·00	1·31	54[1]
April 12	"	....	150	...	....	4·12	4055
April 13	"	1186	150	781	5·27	4·96	4118
April 13	"	1186	150	781	5·44	4·96	4251
June 5..	E. Bankson......	1469	138	387	1·50	1·93	583
June 17.	G. Ebner	1186	133	324	1·24	1·51	401
July 8..	A. Pirie.........	1496	144	674	3·88	4·01	2618
Aug. 13.	G. Ebner	1196	140	341	1·25	1·64	428
Aug. 26.	W. J. Ireland....	1469	137	357	1·35	1·94	490
Sept. 1..	" ...	1469	137	307	1·03	1·47	316
Sept. 23	" ...	1469	122	251	·62	0·98	155
Oct. 13.	C. O. Allen... .	1435	123	258	·65	1·09	167

[1]. Ice measurements.

TABLE No. 66.

DAILY GAUGE HEIGHT AND DISCHARGE, Swan River, near Swan River, Man., for 1912.

[Drainage area, 1,215 square miles.]

Day.	October.		November.		December.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1			2·13	716		
2			1·90	560		
3			1·73	462		
4			1·71	451		
5			1·71	451		
6			1·72	456		
7			1·73	462		
8			1·72	456		
9			1·71	451		
10			1·71	451		
11			1·70	445	1·43	1 25
12			1·70	445		
13			1·69	440		
14			1·69	440		
15			1·69	440		
16			1·68	435		
17						
18						
19					1·23	
20						
21						
22						
23						
24	2·56	1041				
25	2·55	1033				
26	2·51	999				
27	2·42	926				
28	2·35	873			1·23	
29	2·34	865				
30	2 28	821				
31	2·25	800				

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE, Swan

[Drainage area,

Day.	January.		February.		March.		April.		May.	
	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	...	...	...	...	...	...	...	...	2·50	990
2	...	...	...	...	...	...	...	...	2·45	950
3	...	...	...	...	...	...	...	...	2·40	910
4	...	...	1·33	...	...	...	...	...	2·33	858
5	...	...	...	...	...	...	2·40	...	2·42	926
6	...	...	...	...	...	...	...	...	2·71	1169
7	...	...	...	...	...	...	...	...	2·87	1317
8	...	...	...	...	...	...	...	...	2·86	1307
9	...	...	...	...	...	...	...	...	2·79	1241
10	...	...	...	...	...	...	...	...	2·69	1152
11	...	...	1·35	...	...	...	...	...	2·61	1084
12	...	...	1·31	...	...	...	4·12	...	2·57	1050
13	...	...	...	...	...	...	4·96	4166	2·57	1050
14	...	...	...	...	...	...	5·03	4278	2·59	1067
15	...	...	...	...	1·02	...	5·31	4726	2·61	1084
16	...	...	...	...	...	...	5·38	4838	2·61	1084
17	...	...	...	...	...	...	5·37	4822	2·66	1120
18	1·31	...	1·03	...	...	...	5·03	4278	2·63	1101
19	...	...	...	...	...	...	4·81	3926	2·64	1109
20	...	...	...	...	...	...	4·56	3526	2·60	1075
21	...	...	...	...	...	...	4·45	3350	2·55	1033
22	...	...	...	...	...	...	4·50	3430	2·51	999
23	...	...	...	...	...	...	4·37	3222	2·49	982
24	...	...	...	...	...	...	4·17	2905	2·40	910
25	...	...	...	...	...	...	3·82	2398	2·37	888
26	...	...	1·72	...	...	...	3·38	1852	2·37	888
27	...	...	...	...	...	...	3·04	1485	2·35	873
28	1·37	...	...	...	...	...	2·87	1317	2·35	873
29	...	...	...	...	...	...	2·73	1187	2·28	821
30	...	...	...	...	1·70	...	2·63	1101	2·28	821
31	...	...	...	...	...	...	...	...	2·24	793

No. 67.

River, near Swan River, Man., for 1913.

1,215 square miles.]

Day.	June.		July.		August.		September.		October.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	2·20	765	2·39	903	2·04	653	1·51	350	0·98	141
2	2·13	716	2·73	1187	1·97	606	1·46	327	0·96	134
3	2·07	674	3·24	1694	1·87	542	1·51	350	0·97	137
4	1·99	619	4·67	3702	1·68	435	1·53	360	0·95	131
5	1·96	599	4·58	3558	1·57	380	1·53	360	0·95	131
6	1·93	580	4·52	3462	1·50	345	1·53	360	0·93	125
7	1·93	580	4·24	3014	1·44	318	1 46	327	0·99	144
8	1·92	573	3·95	2580	1·39	296	1·42	309	0·99	144
9	1·87	542	3·68	2214	1·41	305	1·51	350	1·01	151
10	1·81	506	3·46	1944	1·40	300	1·48	336	1·07	172
11	1·75	473	3·57	2074	1·50	345	1·45	322	1·07	172
12	1·75	473	3·76	2318	1·62	405	1·35	280	1·09	179
13	1·67	430	3·97	2608	1·65	420	1·30	260	1·10	182
14	1·66	425	4·09	2664	1·70	445	1·26	244	1·12	190
15	1·65	420	4·02	2680	1·86	536	1·20	220	1·10	182
16	1·59	390	3·97	2608	2·06	667	1·18	212	1·08	175
17	1·54	365	3·87	2468	2·19	758	1·15	201	1·09	179
18	1·48	336	3·69	2227	2·22	779	1·11	186	1·05	165
19	1·43	314	3·41	1887	2·24	793	1·10	182	1·02	154
20	1·39	296	3·13	1577	2·25	800	1·07	172	0·88	109
21	1·39	296	2·91	1355	2 30	835	1·05	165	0·90	115
22	1·33	272	2·71	1169	2 34	865	1·04	161	1·13	193
23	1·25	240	2·47	966	2·23	786	1·01	151	1·08	175
24	1·22	228	2·31	841	2·09	688	1 04	161	1·07	171
25	1·29	256	2 18	751	2·00	625	1·08	175	1·01	151
26	1·26	244	2·12	709	1·89	554	1·07	172	1·01	151
27	1·97	606	2·01	632	1·74	467	1·05	165	0·95	131
28	2·06	667	1·97	606	1·64	415	1·04	161	1·23	232
29	2·03	646	1·97	606	1·62	405	1·03	158	1·04	161
30	2·11	702	2·14	723	1·53	360	1·03	158	1·08	175
31	....	....	2·10	695	1·46	327	....	....	1·20	220

RED DEER RIVER.

A.—LOCATION.

The Red Deer river (see plate No. 22) rises in township 44, range 10, west of the second meridian, some 15 miles south of Melford, Sask. It flows in an easterly direction to Red Deer lake, and from thence into lake Winnipegosis.

B.—RIVER BASIN.

Similarly to the Swan river, the Red Deer river flows in a deep wide valley of glacial origin, though of greater extent than the valley of the former river. In the upper portion of the watershed, the drainage is collected by several tributary streams, including the Fir, Etoimami, Pipestone and Barrier rivers, which extend over a large tract of country, and head in many small lakes and swamps. A forest growth, composed of spruce and poplar, covers a great extent of this upper district. In the lower reaches of the river, the drainage to the north is somewhat confined, due to a parallel river system. Some ten miles above the mouth, the river passes through Red Deer lake, which has an area of 100 square miles.

C.—NATURE OF BED AND BANKS.

While rock outcrops occur at a few places in the lower reaches of the river, the bed and banks are for the most part composed of sand, gravel and clay, this latter feature being applicable to a greater portion of the Red Deer valley. The bed of the river is also strewn with boulders at many places. The width of the river is stated to vary from 150 to 250 feet, while the banks are stated to range in height from 15 to 50 feet.

D.—TIMBER AND VEGETATION.

As stated previously, there is extensive growth of timber in the upper portion of the drainage. The Red Deer Lumber Company carry on logging operations in this district and operate a saw-mill on Red Deer lake, the logs being floated downstream to the mill.

E.—HIGH AND LOW WATER.

High water under ordinary conditions occurs in the latter part of April or early May, while low water is stated to occur in the winter months, with a range of some 4 to 5 feet between the two periods. Due to ice jams on the river, an extreme range of 14 feet was noted at one point in the spring of 1913.

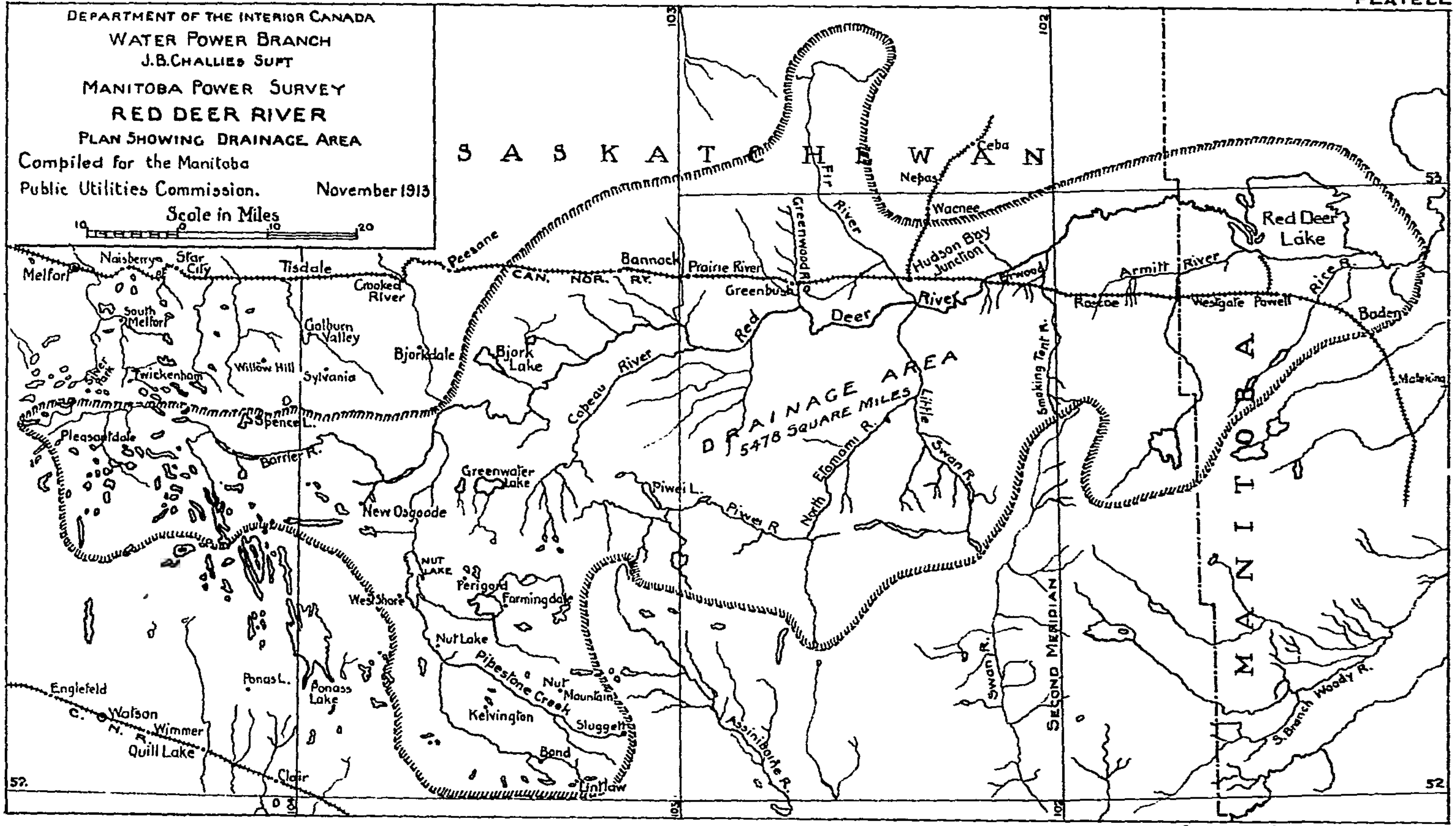
F.—TRANSPORTATION.

The river is spanned by the Canadian Northern railway at Erwood, some 30 miles west of Red Deer lake. The railway above this point is situated within the vicinity of the river for a considerable distance. A spur line of the same railway also taps Red Deer lake at Barrows.

G.—SURVEYS OF THE RIVER.

A geological survey of the river and adjacent territory has been made by the Geological Survey of Canada. On July 5, 1913, a metering station was established by the Manitoba Hydrographic Survey of the river in the vicinity of Hudson Bay Junction.

PLATE 22



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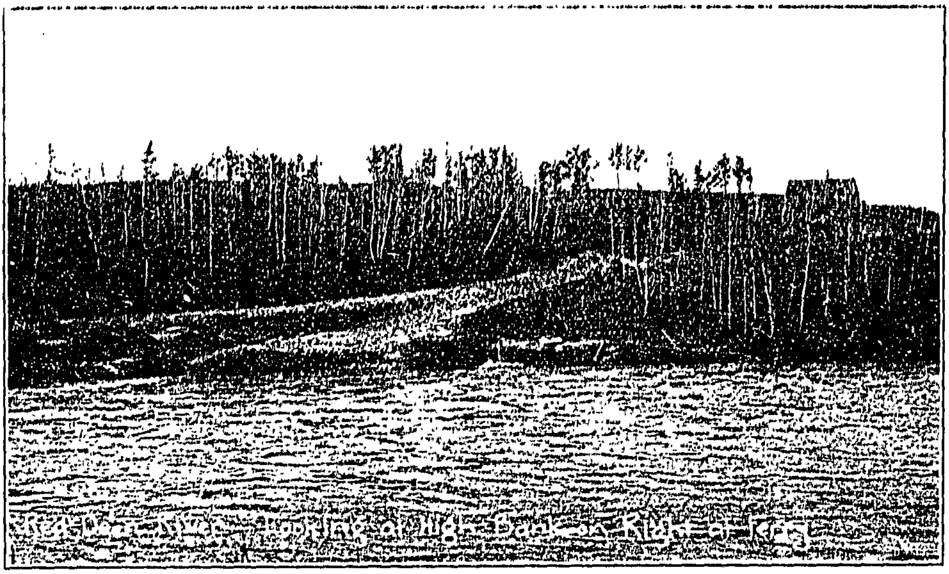
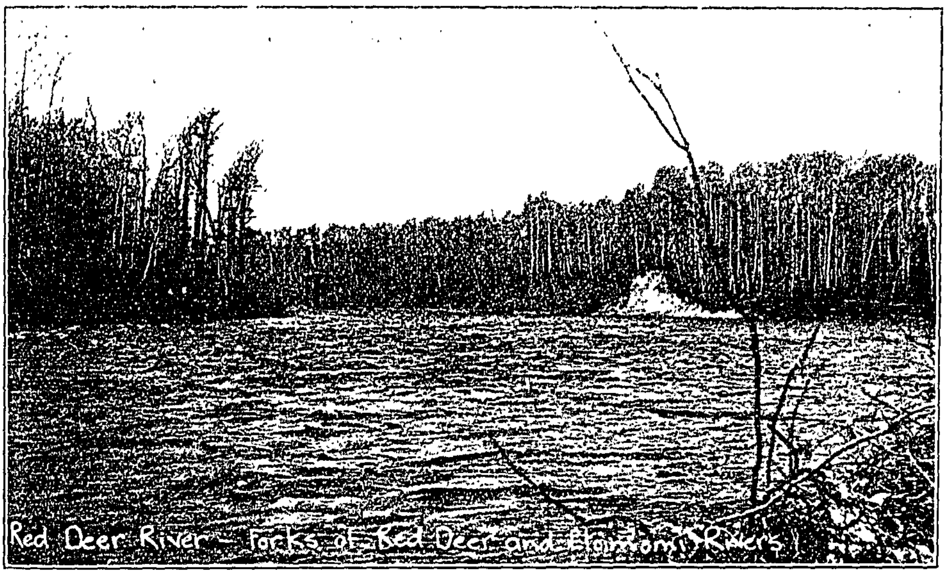


Red Deer River – Looking at High Bank on Right of [illegible]



Red Deer River – Forks of Red Deer and [illegible] Rivers

II.—RUN-OFF.

(*a*) *Precipitation.*—Only meagre records of precipitation are available, and from these it would appear that some 15 inches would represent the mean annual rainfall.

(*b*) *Discharge Measurements.*—As shown in table No. 68, measurements of the discharge have been made near Hudson Bay Junction since July 5, 1913. An estimate of the daily discharge since that date is given in table No. 69.

While these records do not as yet extend over sufficient period to cover a complete water year, it is estimated that the minimum flow is 150 second-feet, this latter figure being subject to revision or verification as future records will indicate.

I.—STORAGE POSSIBILITIES.

No field investigation has as yet been made of the storage possibilities of this river. As many small lakes are situated in the upper drainage, storage should be available, and of sufficient extent to greatly increase the low flow of the river. Red Deer lake, with an area of 100 square miles, offers facilities for a regulation to a considerable extent of the flow from Red Deer lake to lake Winnipegosis. As an indication of the flow available from a one or two-foot storage on a lake of this size, the following table has been prepared. The rates of draft in second-feet are computed for a storage being used in a 6 months or a year period:—

RED DEER LAKE.

Depth of Storage.	Capacity in Billion Cu. ft.	Rate of Draft 6 months.	Rate of Draft 1 year.
1	2,787·84	178	89
2	5,575·68	356	178

J.—WATER-POWER.

The head-waters of the Pipestone creek, one of the Red Deer tributaries, rise in a country whose elevation is some 2,000 feet above sea-level, while lake Winnipegosis has an elevation of some 828 feet; so that, approximately, there is some 1,000 feet fall between the head-waters and the mouth of the river. Considerable fall does occur in Manitoba, the fall between Red Deer lake and lake Winnipegosis is stated by the Geological Survey to be some 45 feet. While field investigations of the power possibilities of the river are as yet to be made, the following tentative table gives the power available per foot head based on an 80 per cent efficiency and computed for an estimated minimum flow of 150 second-feet. As stated above, this latter figure is subject to revision:—

Head.	Estimated Horse-power on 80 per cent Efficiency.
1 foot	13·7
10 "	137
20 "	274

TABLE No. 68.

DISCHARGE MEASUREMENTS of Red Deer River, near Hudson Bay Jct., 1913.

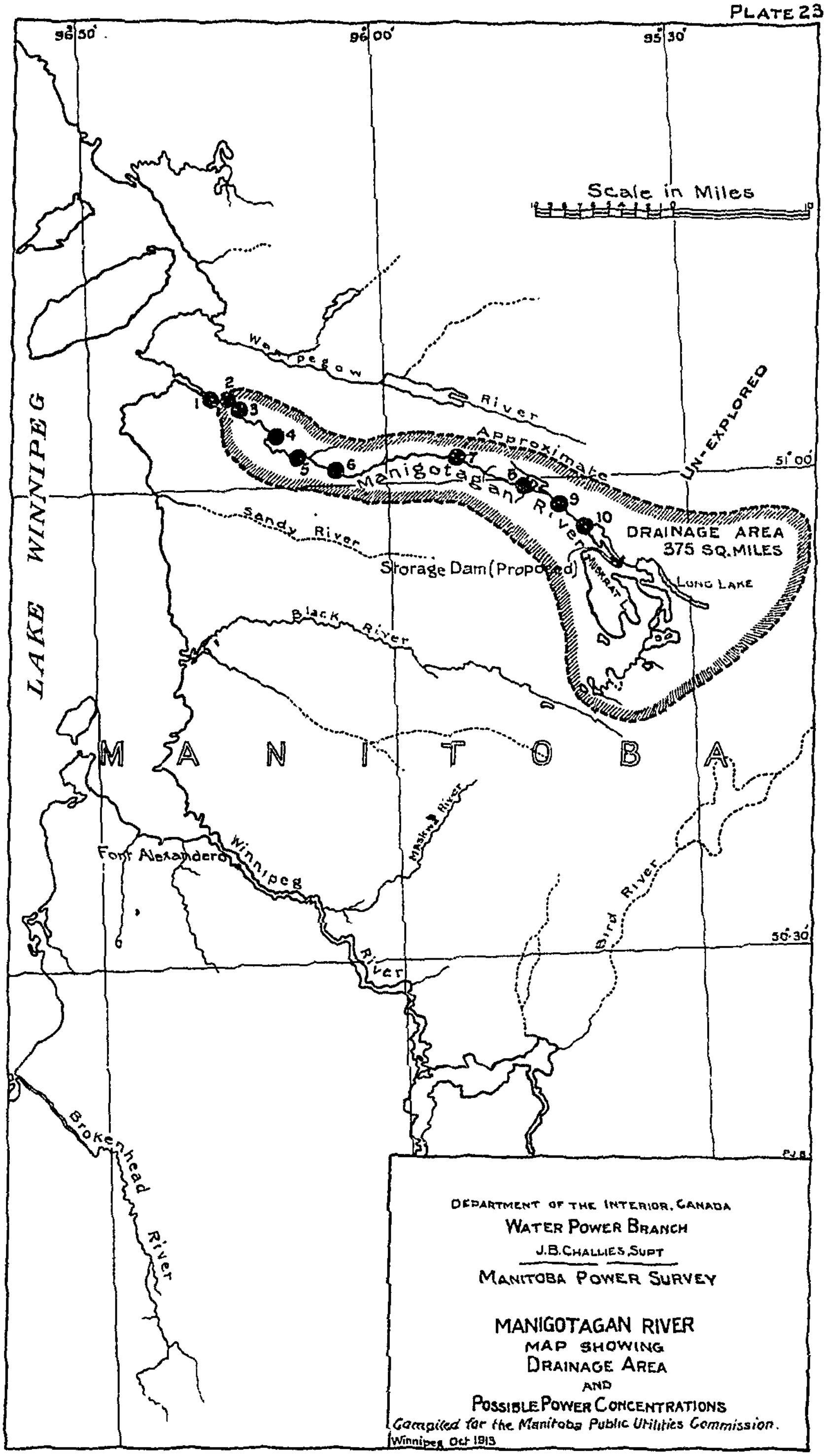
Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
July 5	G. Ebner	1196	183	927	2·53	3·58	2342
" 10	A. Pirie	1496	193	886	2·30	3·31	2034
Aug. 12	G. Ebner	1196	165	765	2·28	3·09	1747
" 30	W. J. Ireland	1469	162	693	2·05	2·79	1419
Sept. 18	W. J. Ireland	1469	162	566	1·36	2·10	768
Oct. 6	C. O. Allen	1435	155	528	1·03	1·78	546

TABLE No. 69.

DAILY GAUGE HEIGHT AND DISCHARGE, Red Deer River, near Hudson Bay Junction, for 1913.

Days.	July.		August.		September.		October.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	3·75	2521	2·77	1394	1·90	625
2	....	....	·63	2383	·82	1451	·86	601
3	....	....	·48	2210	·79	1417	·82	576
4	....	....	·46	2187	·77	1394	·70	507
5	....	....	·32	2026	·74	1359	·77	547
6	....	....	3·19	1877	2·68	1291	1·80	564
7	....	....	·13	1808	·64	1248	·80	564
8	....	....	·09	1762	·56	1164	·80	564
9	3·44	2164	·09	1762	·55	1154	·80	564
10	·28	1980	·10	1773	·42	1025	·81	570
11	3·38	2095	3·13	1808	2·46	1064	1·83	582
12	4·00	2808	·09	1762	·42	1025	·86	601
13	·73	3618	23	1923	·39	997	·82	576
14	5·15	4131	·20	1888	·38	989	·76	541
15	·45	4476	·40	2118	·23	862	·73	524
16	5·60	4648	3·72	2486	2·20	838	1·71	513
17	·68	4740	·66	2417	·16	808	·73	524
18	·50	4533	·67	2429	·11	707	·70	507
19	·38	4395	·69	2452	·08	748	·68	496
20	·17	4154	·66	2417	·08	748	·68	496
21	4·95	3901	3·62	2371	2·05	727	1·65	481
22	·80	3728	·59	2337	·05	727	·68	496
23	·63	3533	·37	2084	·04	719	·68	496
24	·49	3372	·37	2084	·03	712	·71	513
25	·30	3153	·16	1842	·02	705	·60	454
26	4·44	3314	3·05	1716	2·02	705	1·70	507
27	·45	3326	2·92	1566	·01	698	·80	564
28	·40	3268	·89	1532	·00	691	·60	454
29	·25	3096	·82	1451	1·97	671	·40	363
30	·09	2912	·76	1382	·94	651	·73	524
31	3·86	2647	·77	1394	....	....	·73	524

PLATE 23



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Stuart S. Scovil Asst Chief Engineer

WATER-POWERS OF MANITOBA

CHAPTER VI

RIVERS IN EASTERN PORTION OF MANITOBA

CHAPTER VI.

RIVERS IN THE EASTERN PORTION OF MANITOBA.

MANIGOTAGAN RIVER.

GENERAL DESCRIPTION OF RIVER AND WATERSHED.

A.—LOCATION.

The Manigotagan or Bad Throat river discharges into lake Winnipeg at an inlet on the east shore, about 50 miles north of Fort Alexander and almost directly opposite the centre of Big island. (*See* plate No. 23.)

B.—GENERAL DIRECTION.

The general bearing of the river is west 30 degrees north from Musk Rat lake to its mouth. The flow into Musk Rat lake is said to come from the northeast.

C.—RIVER BASIN.

While the upper reaches of the watershed have not yet been explored, yet it is stated that considerable drainage comes in beyond Long lake. From Long lake to Turtle lake the basin widens out and includes the Caribou, Musk Rat, Moose, Bull Frog and many other small lakes. From Turtle lake to the river mouth there are a number of small creeks draining the adjoining swamps and muskeg. All of these are small and sluggish at their entrance to the river.

D.—NATURE OF BANKS.

At the mouth of the river the banks are of good agricultural clay, partially cleared and occupied by settlers. Even here, however, rock outcrops are found at several places. Above Wood falls the banks are very irregular and in most cases rocky, ranging from 2 feet to 60 or 70 feet in height, being broken by many valleys which lead back to muskegs or swamps. In the upper reaches, ranges of hills skirt the river on either side.

E.—WIDTH OF RIVER AND NATURE OF BOTTOM.

For the first 25 miles the river has an average width of about 175 feet, narrowing down at the many rapids and falls; three or four miles below Turtle lake the channel widens, and from that point to Musk Rat lake there are many places in which it has a width of from 700 to 900 feet. Below each rapid a large circular pool from 500 to 800 feet in diameter is a feature that is noticeable. The banks are overgrown with grass and reeds which extend into the river 50 feet in many places, while willows and alders are found at many points where the banks are low. The river bed is covered with black muck except at falls and rapids, where boulders and rock form the bed.

F.—TIMBER AND VEGETATION.

Almost the entire drainage area is covered with an inferior class of timber which includes a plentiful supply of poplar and spruce, together with jack pine, birch, oak and balsam. In the vicinity of Musk Rat lake, and beyond Moose lake, there is a fringe of valuable spruce bordering the lakes, but this does not appear to extend far

back into the interior. In the immediate vicinity of the river valuable timber has been removed, but fire does not seem to have had any hand in depleting the supply, as is often found where first cutting has been made.

G.—HIGH AND LOW WATER.

High water usually occurs in June, when a height of 3½ or 4 feet above the low-water mark has been noticed. Low water occurs in the fall, and in March or April.

H.—TRANSPORTATION.

Small steamers can navigate to the foot of Wood falls, but beyond this point canoes are the only means of transportation on account of the numerous rapids and falls. A winter road has been cut through from Manigotagan settlement to Musk Rat lake. This road crosses and recrosses the river, and so is only of use during the severe winter months.

I.—SETTLEMENTS.

The only permanent settlement at present is at the Manigotagan post office at the mouth of the river. The Phœnix Brick, Tile and Lumber Company have been making brick at this point with a modern plant, and have also operated a sawmill in conjunction with their brick plant.

J.—SURVEYS OF THE RIVER.

The Geological Survey of Canada made a geological reconnaissance of this river in 1890 and 1891 from its mouth to Long lake; since that time a few isolated land surveys for timber berths and settlement areas have been made. In December, 1912, a meter station was established by the Manitoba Hydrographic Survey and a reconnaissance made of Wood and Poplar falls. In the following year during the month of June a reconnaissance of the river from Wood falls to Long lake was made by the Manitoba Hydrographic Survey, with D. B. Gow in charge of party.

K.—RUN-OFF.

(*a*) *Rainfall.*—There are no rainfall records available for this drainage area, but it is estimated that a mean annual rainfall of some 21 inches might be expected.

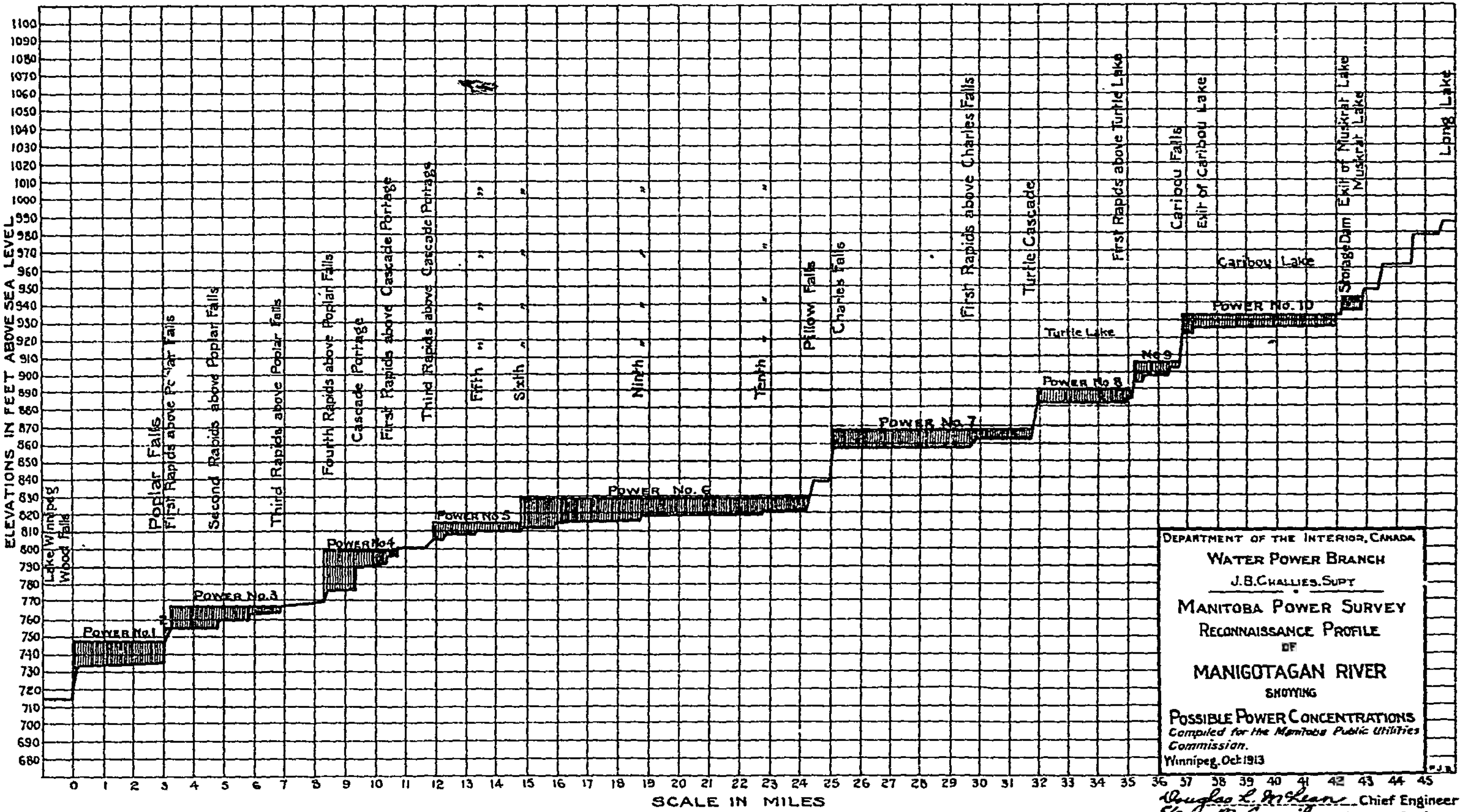
(*b*) *Discharge Measurements.*—Meterings have been taken at the mouth of the river by the Manitoba Hydrographic Survey and results of this work estimated to the end of the year 1913, may be found in tables No. 70 and No. 71. From these records it will be seen that the minimum discharge would be about 30 second-feet, and the flood discharge some 1,200 second-feet.

(*c*) *Mass Curve, 1913.*—By using the run-off data at present on hand for 1913 and estimating the probable flow for the remaining months of the year, it is found that a uniform flow of 150 second-feet could have been maintained had there been a storage reservoir capable of holding 1·45 billion cubic feet of water. (*See* plate No. 25.)

L.—STORAGE POSSIBILITIES.

From mass curve studies for year 1913 it will be seen that a storage of 1,450,000,000 cubic feet would be required to produce uniform run-off; this could be obtained by using Musk Rat lake. This lake has an area of 8·3 square miles, and it would be possible to store some 7·8 feet. This would give a storage capacity of 1·8 billion cubic feet, so that ample storage could be provided for on this lake.

PLATE 24



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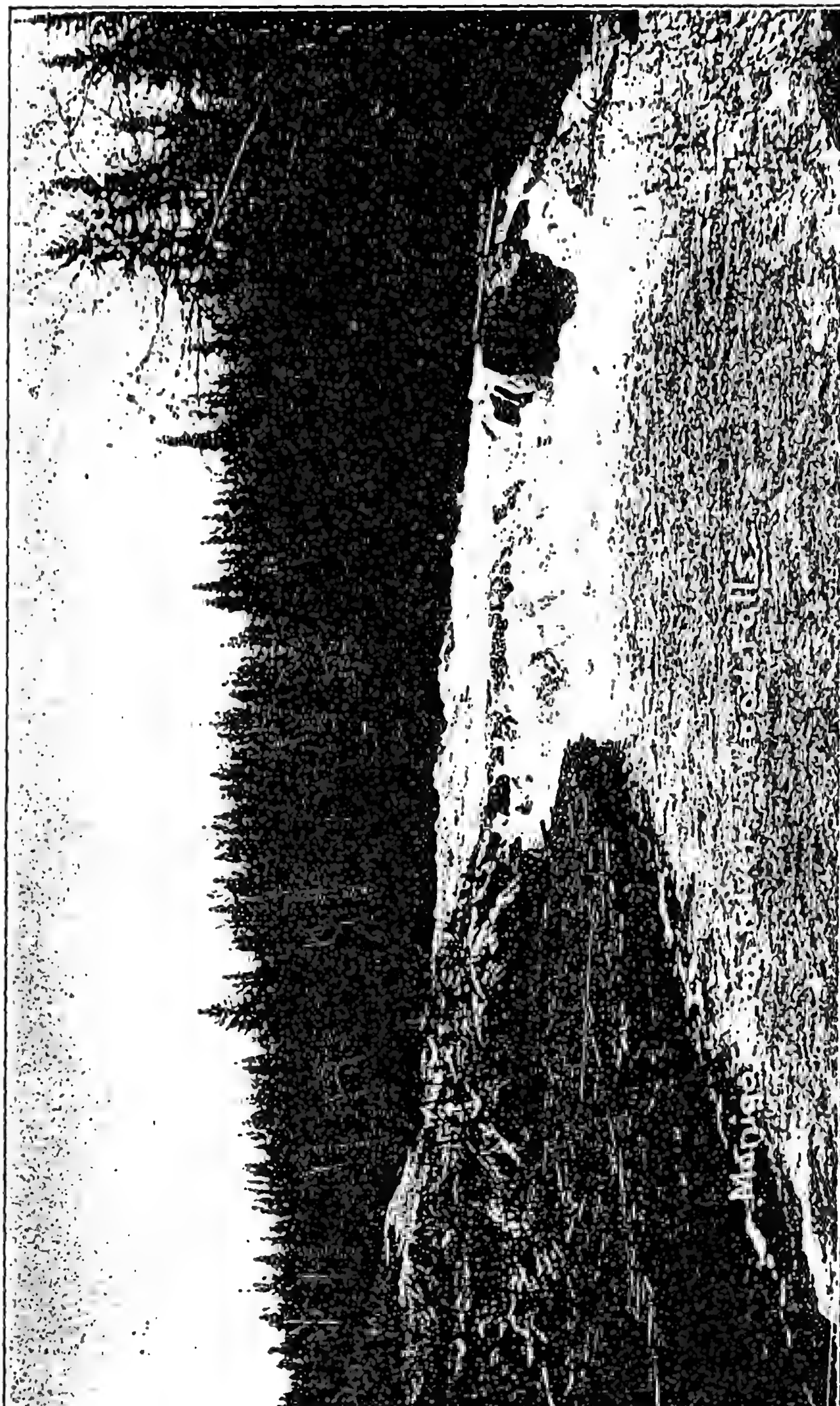
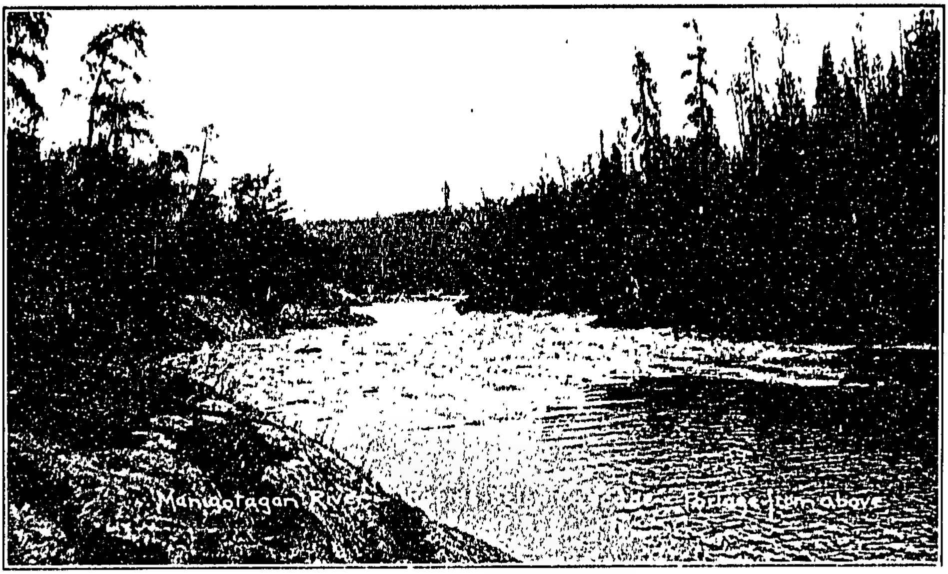
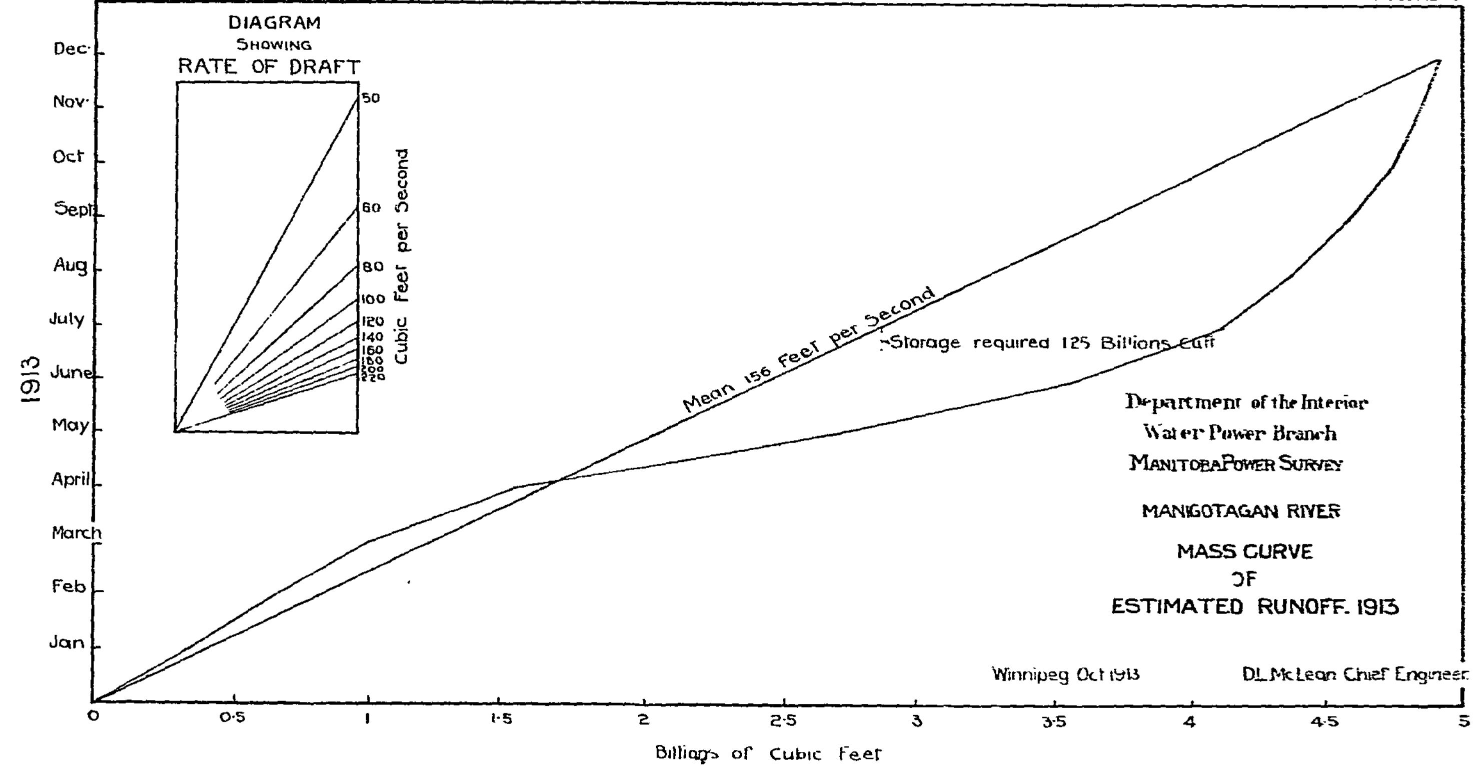



Manigotagan River–
Portage from above


Manigotagan River– Wood Falls, N. Side of Dam Site.

Plate 25



Department of the Interior
Water Power Branch
Manitoba Power Survey

MANIGOTAGAN RIVER

MASS CURVE
OF
ESTIMATED RUNOFF. 1913

Winnipeg Oct 1913

D.L. McLean Chief Engineer

M.—WATER-POWER.

There are a number of water-powers on the river that might be developed, and these are shown on the profile, plate No. 24. The following tabulation shows possible power concentrations under conditions of minimum flow and under regulated flow based on records of 1913, and gives the power at 80 per cent efficiency:—

No.	Name.	Head.	Horse Power Estimated on 80 per cent Efficiency.	
			Min. Flow.	Reg. Flow.
1....	Wood falls....	33	90.	419
2...	Poplar falls.....	8	22	109
3....	First rapid above Poplar falls...............	12	33	163
4 ...	4th rapid above Poplar falls...	30	82	408
5...	3rd rapid above Cascade Portage	12	33	163
6 ...	6th rapid above	18	49	245
7....	Charles falls.........	34	92	462
8....	Turtle cascade..........	28	76	381
9 ..	2nd rapid above.	21	57	2-6
10....	Caribou falls.......	27	74	368
	Total Horse-power.	....	608	3031

TABLE No. 70.

Miscellaneous Measurements in Manigotagan River drainage basin in 1912-13, by Manitoba Hydrographic Survey.

Date.	Stream.	Locality.	Gauge Height.	Discharge.
1912.			Feet.	Sec.-feet.
Dec. 28.	Manigotagan......	Wood falls*...	4·00	144
1913.				
May 26.	"		*5·1	469
May 31.	"	1½ Miles below Cascade Portage*....	*5·0	423
June 4.	"	2 Miles below Turtle Lake,....	...	323
June 7.	"	Outlet of Muskrat Lake..........	....	288
June 10.	"	Head of Muskrat Lake...........	....	168
June 14.	"	Outlet of Moose Lake....	....	47
June 18.	"	Caribou Rapids...	....	293
Aug. 23.	"	Wood falls.......	*3·74	93

* Referred to Gauge above Wood Falls.

TABLE

DAILY GAUGE HEIGHT AND DISCHARGE,

[Drainage area,

Day.	January.		February.		March.		April.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1			3·95		3·90			
2								
3								
4	4·00							
5							4·00	
6								
7								
8			3·95		4·00			
9								
10								
11	4·00							
12							3·80	
13								
14								
15			3·95		4·00			
16								
17								
18	3·95							
19							4·60	290
20							55	276
21							4·53	276
22			3·90		4·00		·50	262
23							50	262
24							·50	262
25	3·95						·50	262
26							4·50	262
27							·58	284
28							·60	290
29					4·00		·60	290
30							·60	290
31								

No. 71.

Manigotagan River, above Wood Falls, for 1913.

313 square miles.)

Days.	May.		June.		July.		August.		September.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height.	Dis-charge.	Gauge height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	4·70	320	5·00	424	4·80	352	3·84	112	3 69	87
2	·70	320	4·99	420	·40	235	·84	112	·89	1·21
3	·77	342	5·00	424	·50	262	·84	112	·66	·83
4	·80	352	00	424	·50	262	·74	95	·46	·55
5	·84	366	·10	464	·40	235	3·94	131	·66	·83
6	4·90	386	4·90	386	4·40	235	3·84	112	... ...	.... .
7	·92	394	·90	386	·30	210	·84	112	....	.... .
8	·90	386	·90	386	·80	352	·74	95	......	......
9	·96	409	·80	352	·30	210	·74	95	... ...	......
10	5·00	424	·80	352	·20	186	·34	42	... ...	......
11	5·00	424	4·80	352	4·30	210	3·64	80	....	....
12	·08	456	·75	336	·30	210	·74	95	... .	....
13	·10	464	·73	330	·30	210	·74	95	....	.... .
14	·10	464	·70	320	·40	235	·84	112	.. ....	......
15	·10	464	·70	320	·20	186	·84	112	... ..	....
16	5·00	424	4·69	317	4·20	186	......	110	... ..	......
17	·10	464	·69	317	·20	186	....	110	....	......
18	·10	464	·70	320	·50	262	......	105	....	.. . .
19	·12	473	·80	352	·10	164	....	105	... ..	.. ...
20	·12	473	·60	290	·10	164	....	105	... .	.. ...
21	5·10	464	4·60	290	4·20	186	....	100	....	.... .
22	·10	464	·60	290	·20	186	....	100	....	......
23	·10	464	·50	262	·10	164	3 74	95	... ..	....
24	·10	464	·70	320	·00	143	·74	95	....	....
25	·10	464	·60	290	·10	164	·76	99	... .	..
26	5·10	464	4·60	290	4 10	164	3·64	80	.... ..	.. .
27	·10	464	·50	262	·10	164	·66	83	... .	... ..
28	·08	456	·60	290	·10	164	66	83	....	.... ..
29	·00	424	·50	262	·10	164	·66	83	.... .	. ...
30	·10	464	·50	262	·20	186	·67	84	....	.. ..
31	·00	424	....	....	·10	164	·66	83	....	.... ..

BLOODVEIN RIVER.

A.—LOCATION.

The Bloodvein or Miskowow river (*see* plate No. 26) discharges into a bay on the east shore of lake Winnipeg situated at the northerly portion of the narrows separating the two main bodies of the lake.

B.—DIRECTION OF FLOW.

In the upper reaches the river flows in a westerly direction, but in the vicinity of lake Winnipeg the river bends slightly to the north.

C.—GENERAL DESCRIPTION OF RIVER AND BASIN.

While little is known of the head-waters of the river, it is estimated that the drainage basin comprises an area of 3,000 square miles. The greater portion of the basin is rocky and of granitic formation, with the occurrence, at some few places, of a light covering of clay. Several small tributary streams enter the Bloodvein from the north, and in the upper watershed the river is divided into two branches, the northerly branch heading in Sassaginnigak lake, while the southerly branch is stated to reach out to the height of land separating this drainage basin from that of the English river

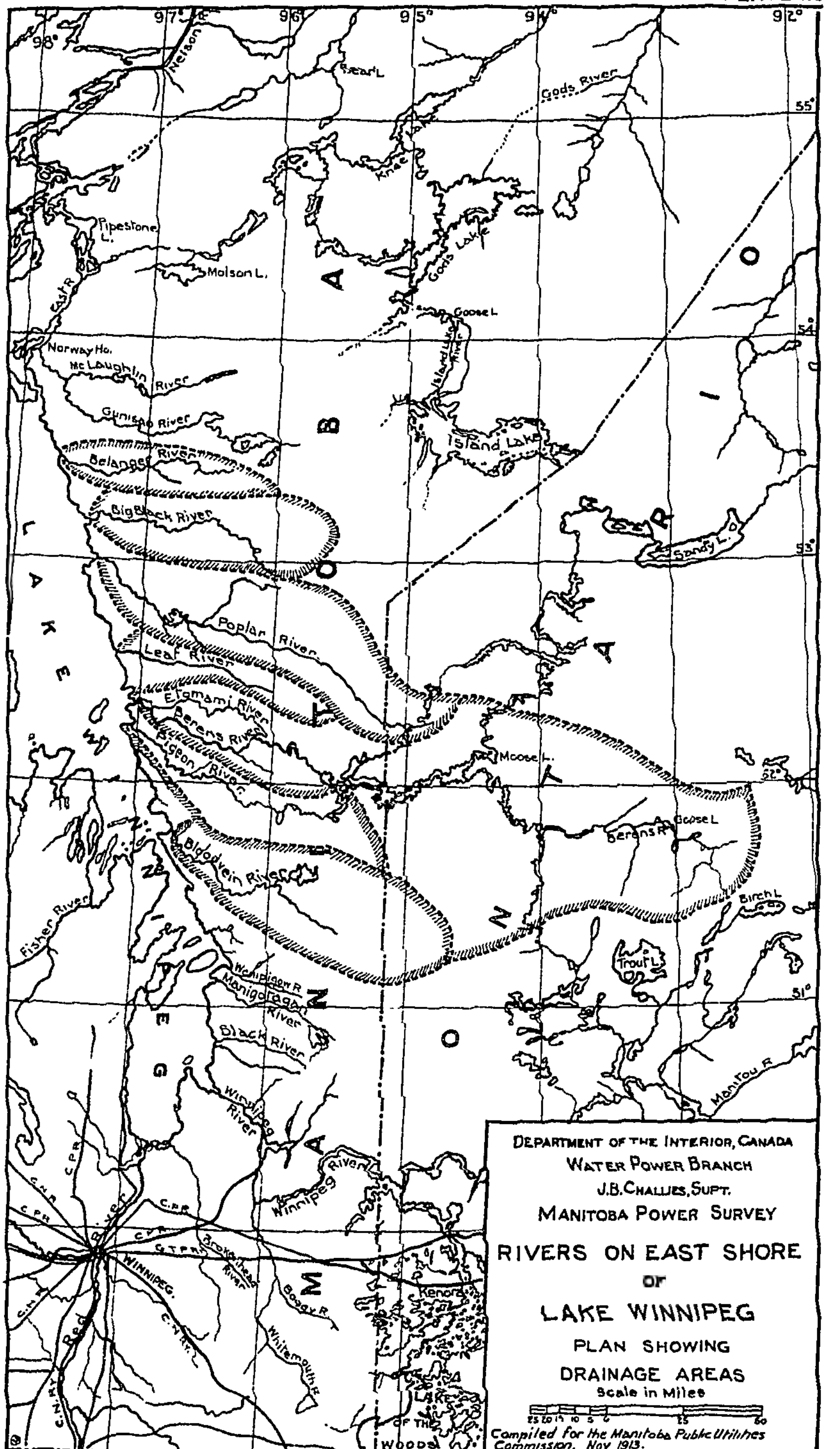
In the vicinity of the mouth, the banks of the river, which has an average width of 150 feet, are composed of clay, and about 5 feet in height. Some 9 miles up stream the first rapids on the river occur. A short distance above this point the Little Bloodvein river is tributary in a stretch where the river makes several sharp bends. From this point to the junction of the Turtle river, a distance of from 35 to 40 miles, there are many rapids and falls, some of which are stated to have deep descents; the banks, for the most part, are rocky and low, giving way occasionally to marsh and muskeg, yet at some places they rise from 10 to 20 feet in height, being at these points composed of clay or clay and gravel overlying the rock outcrop. The country in the vicinity of the river is stated to be very rocky, with a very slight covering of soil. It is also stated that the district presents the same general characteristics until in the vicinity of Kowtunigan lake, at which point the north and south branches of the river occur. The south branch heads in a region of which little is known, while the north branch again operates into two branches both of which head in the same lake. This lake, which is known as the Sasaginnigak lake, and is stated to have an extreme length of about four miles and a width of about two, is dotted with numerous islands. Of the territory tributary to the lake little is known.

D.—NAVIGATION AND ACCESSIBILITY.

Navigation of this river is impossible other than by canoe, and even by this means many portages are necessary. The mouth of the river is easily reached during the summer months, as it is within a short distance of the route followed by steamers on lake Winnipeg.

E.—WATER-POWER.

Similar to most rivers discharging into lake Winnipeg from the east, the adjoining country is rocky and many rapids occur throughout the extent of the river. While no survey as yet has been made as to the power possibilities of this river, the information available would indicate that there are such possibilities. Based on an assumed mean annual run-off of 0·3 second-feet per square mile and a drainage area of 3,000 square miles, the mean annual discharge would be 900 second-feet.



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Stuart S. Sawyl(?) Asst. Chief Engineer

PIGEON RIVER.

A.—LOCATION.

The Pigeon river (*see* plate No. 26) discharges into lake Winnipeg at a point on the easterly shore, some six miles below the mouth of the Berens river.

B.—GENERAL DIRECTION.

For the first 20 miles below the head-waters, the course of the river is due west, but below this the flow is in a northwesterly direction to lake Winnipeg.

C.—RIVER AND BASIN.

The river basin, which comprises an area of 925 square miles, has its head-waters in Family lake, through which the Berens river is also stated to flow. In its course, the river at various points widens out into several small lakes including Round lake, Goose lake and Little Goose lake. The banks of the river, for the most part, are composed of clay overlying beds of granite, which outcrop both at the rapids and falls, and many points along the river.

In the stretch of river from the mouth to Sturgeon falls, in extent some 14 miles, there is the occurrence of some two rapids. Above Sturgeon falls the banks at first give way to marshy indentations, but further upstream clay banks, gradually rising to a height of some 11 feet, again occur. In this stretch of river from Sturgeon to Poplar falls, which in a direct line between the two points is some 10 miles, the stream is very winding and sluggish. Many rapids occur between Poplar falls and Round lake, with the banks for the greater part slightly higher than found below. Above Round lake the country is stated to be hilly and rocky, with a much thinner overlying blanket of clay. Many rapids and falls occur throughout this portion of the river, some of them being stated to have sharp descents of from 14 to 20 feet.

D.—TRANSPORTATION AND ACCESSIBILITY.

Due to the many rapids on the river, necessitating portages, navigation is only possible by canoe. Lake steamer in the summer months and dog team in the winter form the only means of access to the river.

E.—WATER-POWER.

No field investigation has yet been made as to the power possibilities of this river, yet the existence of many rapids and falls would indicate possibilities of power concentration, and also the occurrence of several lakes along the river would suggest storage possibilities. Assuming that the mean annual run-off is 0·3 second-feet per square mile, would give a mean annual discharge of approximately 270 second-feet at the outlet of the river.

BERENS RIVER.

A.—LOCATION.

The Berens river (*see* plate No. 26), which is the largest river with the exception of the Winnipeg draining the territory to the east of lake Winnipeg, discharges into an inlet of this lake approximately 140 miles north of the southerly end of the lake.

B.—DIRECTION OF FLOW.

From the head-waters to lake Winnipeg, the general course of the river is in a westerly direction.

C.—RIVER AND BASIN.

The extent of the drainage basin of the Berens river is estimated at 7,800 square miles, and the total length of the river in the neighbourhood of 300 miles. The head-waters of the drainage which are situated in Ontario, are encircled by the height of land in which lies the source of the Severn and Albany, and also tributary English river drainage. In Manitoba, in the vicinity of lake Winnipeg, the basin is confined between those of the Pigeon, Leaf and Poplar rivers. While the head-waters as yet have not been fully explored, it is known that the river widens out into many lakes, together with tributaries heading and passing through several lakes, the main tributaries being the Windfall, White, Crooked Mouth, and Etiomami rivers. The general nature of the country is rocky, with a varying depth of overlying clay soil. In the reaches of the river from the mouth to the junction of the Etiomami river, a distance of six miles, the banks which vary in height from 10 to 20 feet, are alternately composed of rock and clay, occasionally giving way to low-lying swamp land. Some 5 miles above the entrance of this tributary, the first rapids which is stated to be of some 9 feet drop, is encountered. From this rapids to Family lake, which is situated some 18 miles west of the Manitoba boundary, there are stated to be fifty-two rapids and falls of varying height, but all of which require portages. The main descent, which is known as Grand rapids is at the outlet of Family lake and is stated to be approximately a 40-foot drop. Family lake is triangular in shape, very irregular in outline, and about 10 miles in length. In this lake the Pigeon river is also stated to obtain its source. A short distance above Family lake, another rapid with a drop of some 35 feet occurs, while slightly beyond this, the river again widens out into Black or Fishing lake, which is some 9 miles in length and 2 to 4 miles in width. In this portion of the basin the country becomes more rugged, and instead of the very low hills in the vicinity of the mouth, the latter range in height from 125 to 150 feet above the lake level. Between Eagle lake, which is situated on the provincial boundary, and Fishing lake, there are many small rapids. The difference in elevation between the two lakes is stated to be some 50 feet. Above Eagle lake, in Ontario, the river widens out into several lakes with many rapids intervening.

D.—SETTLEMENTS.

Outside of the Indian reserve, which is situated at the mouth of the river and two Hudson Bay posts, one at the mouth and one at Grand Rapids, no settlements occur in the vicinity of the river.

E.—NAVIGATION AND ACCESSIBILITY.

The river is not navigable other than by canoe, and in this latter manner many portages are necessary. Though no railroads are as yet located in this district, the river is accessible at its mouth by lake steamer during the period of navigation on lake Winnipeg.

F.—RUN-OFF.

(*a*) *Precipitation.*—Records of the annual precipitation are available for a period of 5 years at a station situated at the mouth of the river, and though not of sufficient duration to show the extreme variations, they indicate an annual mean of some 21 inches.

(*b*) *Discharge Measurements.*—While a discharge measurement of 1,215 second-feet was obtained on this river on October 1, 1913, by Alexander Pirie, of the Manitoba Hydrographic Survey, the flood and minimum discharges are not as yet, obtained.

G.—WATER-POWER.

Considering the extent of the drainage basin, together with the numerous lakes occurring therein, and the many rapids and falls throughout the course of the river, both in Manitoba and Ontario, the power possibilities of the river are extensive. The fall which occurs between Goose lake, lying in the head-waters, and the mouth, is stated to be some 1,200 feet, a drop of approximately 500 feet, and of this a great portion occurs in the province of Manitoba.

Poplar River.

A.—LOCATION.

The Poplar river (*see* plate No. 26) flows into an inlet on the east shore of lake Winnipeg about midway between the north and south extremities of the upper main body of the lake.

B.—GENERAL DIRECTION.

The general bearing of the river from its source to lake Winnipeg is in a northwesterly direction.

C.—RIVER AND BASIN.

The Poplar river has a drainage basin of an approximate area of 1,950 square miles. The lower portion of the drainage is confined between the Big Black and the Leaf river systems, but above this the drainage widens out. Great portions of this upper watershed are stated to be low and swampy, with rocky ridges at various points. Practically all drainage from the head-waters passes through Thunder lake, situated some 25 miles above the mouth of the river.

D.—NAVIGATION AND ACCESSIBILITY.

Similar to practically all streams discharging along the east shore of lake Winnipeg, the Poplar river is only navigable by canoe, and as no railroad as yet extends through this territory, the only means of access is by lake Winnipeg steamers.

E.—SETTLEMENTS.

An Indian reserve is situated at the mouth of the river, but no other settlements are in the immediate vicinity.

F.—POWER POSSIBILITIES.

The power possibilities of this river have not as yet been investigated, but it is stated that several rapids occur, the more important being in the reach of the river below Thunder lake. An estimate of the mean annual discharge of the river, based on a run-off of 0·3 second-feet per square mile, per year would give a discharge of some 585 second-feet.

Big Black River.

A.—LOCATION.

The Big Black river (*see* plate No. 26) discharges into an inlet on the east shore of lake Winnipeg, about 40 miles south of the northerly extremity of the lake.

B.—GENERAL DIRECTION.

The general direction of the river from its source is northwesterly, though at mid-point in its course it obtains a more westerly bend.

C.—RIVER AND BASIN.

While little is known of the head-waters of the drainage area, the latter is estimated to be 1,350 square miles. About 40 miles above the mouth, the Pelican river is tributary to the Big Black. In the country tributary to the stretch of river from the mouth to the junction of the Pelican, the overlying soil is clay, with rock outcrops. In the upper reaches the land is stated to be low and swampy, and the banks marshy, with fringes of reeds and rushes extending into the river. In the lower reaches comprising the clay belt, a mixed growth of pine, spruce, balsam and poplar is reported, but the growth in the upper watershed is principally of willows.

D.—NAVIGATION AND ACCESSIBILITY.

The river is only navigable by canoe, and the only means of access is by boat from Selkirk during period of navigation.

E.—SETTLEMENTS.

There are no settlements in the vicinity of the river, but it is stated that trappers frequent the region in winter in quest of fur.

F.—RUN-OFF.

Assuming a drainage of 1,350 square miles and mean annual run-off of 0·3 second-feet per square mile, this would give a mean annual discharge of some 400 cubic feet per second.

G.—POWER POSSIBILITIES.

Being situated in an unsurveyed portion of Manitoba, and also at a point which is difficult of access, little is known as to the extent of the fall occurring on this river, but from what information is available it is known that there are rapids at several points.

BELANGER RIVER.

A.—LOCATION.

The Belanger river (*see* plate No. 26) discharges into lake Winnipeg on its eastern shore about 20 miles from the northerly end of the lake.

B.—GENERAL DIRECTION.

The river, which has its source in the vicinity of Gunisac lake, flows in a westerly direction to lake Winnipeg.

C.—RIVER BASIN.

The Belanger river drains an area estimated to be 730 square miles. The basin is narrow, being from 10 to 15 miles in width and lying between the Gunisac river to the north and the Big Black river to the south. The country for the most part is level, with the exception of a few rocky hills.

D.—NATURE OF BANKS.

For the first nine miles above the mouth the banks are stated to be from 6 to 15 feet in height, and composed of clay with very few rock outcrops. Outcrops do, however, occur at all rapids throughout the extent of the river. The banks above the first rapids gradually increase in height to some 18 feet, being still composed of clay. In the upper reach of the river, rock outcrops and overlying soil of clay are encountered both at rapids and along the quieter stretch of the river.

E.—WIDTH OF RIVER AND NATURE OF BOTTOM.

For the first 9 miles the river is stated to vary in width from 200 to 300 feet; above this the river narrows and in the head-waters the bed is strewn with boulders.

F.—TIMBER AND VEGETATION.

It is stated that a considerable portion of the tributary territory has been burnt over, with the destruction of considerable timber, but there is still a growth of poplar and black spruce in the vicinity of the river. In the upper reaches timber growth still remains in a state of nature.

G.—NAVIGATION AND ACCESSIBILITY.

Due to several rapids on the river, navigation is only possible by either row-boat or canoe. During the open season of lake Winnipeg navigation, the mouth of the river is accessible by steamer from Selkirk, but during winter months dog team is the only means of access.

H.—RUN-OFF.

Though the upper reaches of the watershed have not been as yet explored, it is estimated that the Belanger river has a drainage area of 730 square miles. Assuming that the mean annual run-off is 0·3 cubic feet per second per square mile, this would give a mean annual discharge of 225 cubic feet per second at the outlet.

In the absence of discharge measurements, no estimate is made as to the flood or minimum flow, and even the mean stated above is subject to revision when such data is obtained.

I.—POWER POSSIBILITIES.

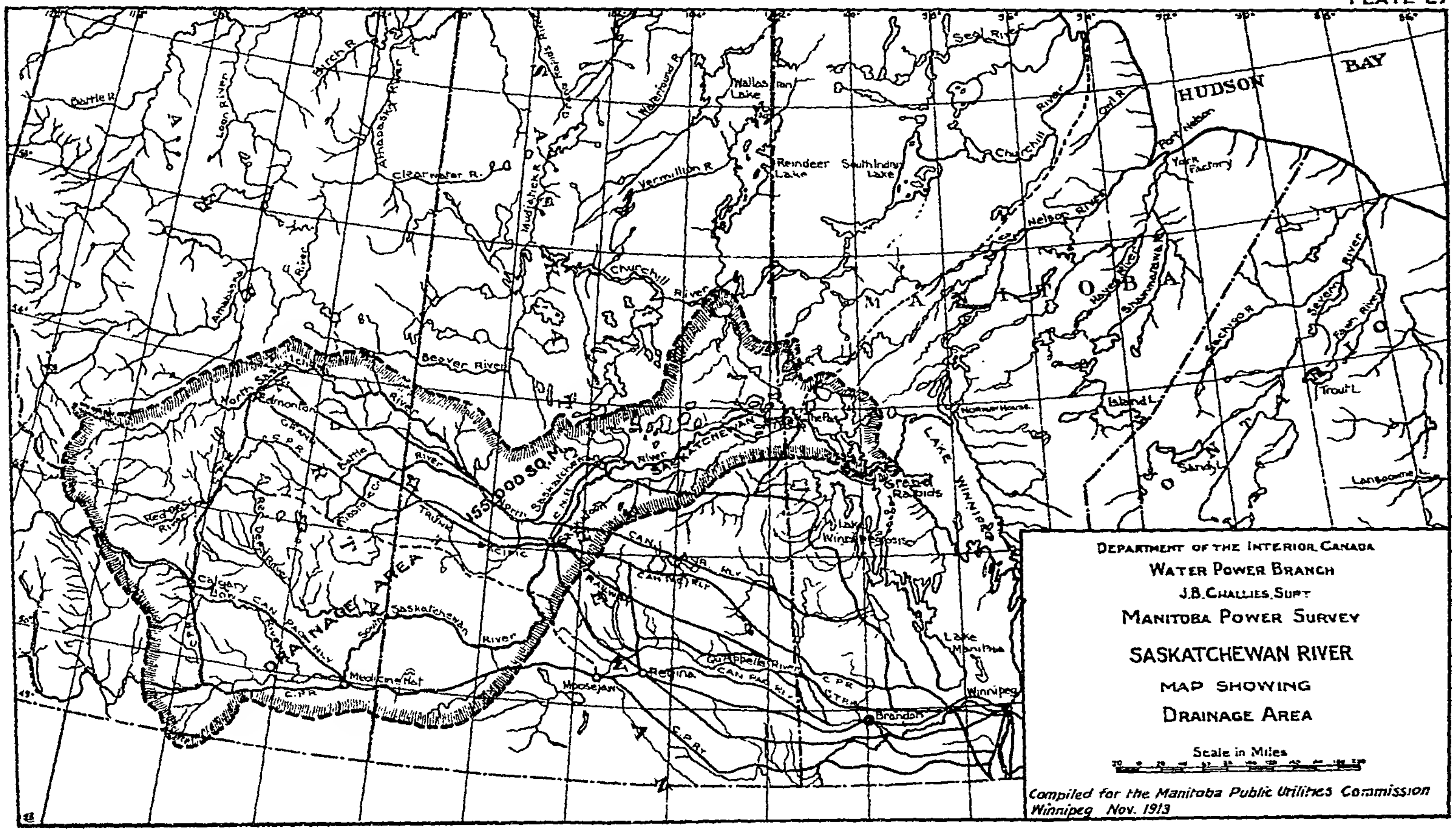
Investigations as to the power possibilities of this river have as yet not been made, but it is known that considerable drop occurs throughout the river, and also that this drop is concentrated at several points, which would indicate power possibilities. At the first rapids above the mouth a drop of about 8 feet is reported, while above this there are many rapids which are impossible to navigate and necessitate portages

WATER-POWERS OF MANITOBA

CHAPTER VII

SASKATCHEWAN RIVER

PLATE 27



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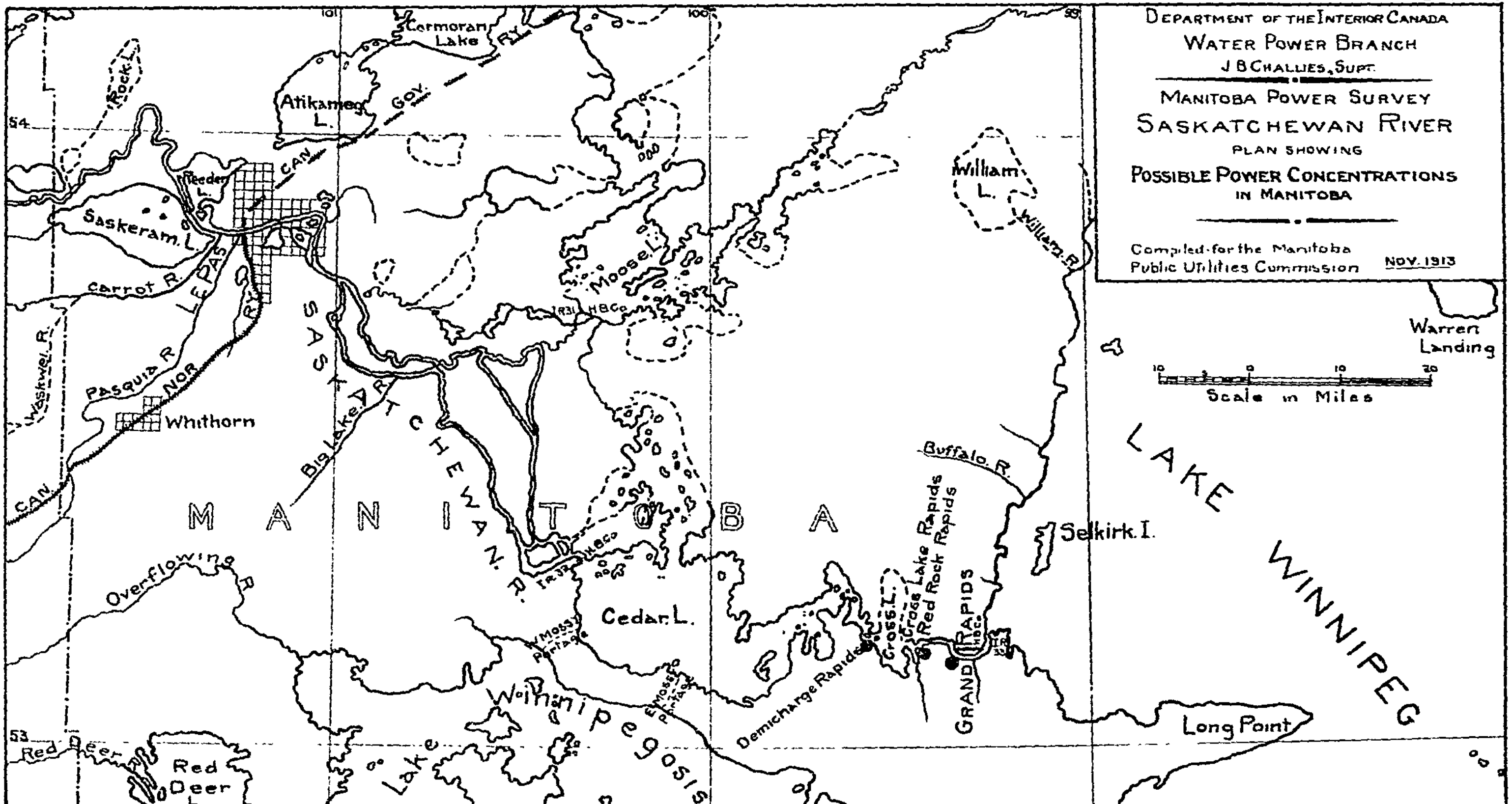
Stuart S. Storey Asst Chief Engineer



Douglas L. McLean Chief Engineer
Stuart S. Searf Asst. Chief Engineer

CHAPTER VII.

THE SASKATCHEWAN RIVER IN MANITOBA.

A.—LOCATION.

The Saskatchewan river enters Manitoba from the west, (*see* plate No. 28), crossing the boundary between Saskatchewan and Manitoba almost directly opposite the north end of lake Winnipeg, and enters the lake some 50 miles south of the lake's northerly end.

B.—RIVER BASIN.

The area drained by the Saskatchewan river (*see* plate No. 27) which is in extent, approximately, 155,000 square miles, comprises a great portion of the western plains The head-waters lie in the Rocky mountains, and the drainage, though collected by many tributaries, is carried across the prairies by two large rivers, known as the North and South Saskatchewan. The North branch heads in the Rockies west of Edmonton, while the Southern branch heads in the same mountain range approximately on a line west of Medicine Hat. Intermediate between these two branches is situated the Red Deer river, a stream of almost as great an extent as the Southern branch which it joins. The distance between the two rivers gradually diminishes with a consequent contraction of the drainage until about 30 miles below Prince Albert the junction of the north and south branches occurs. From the junction to lake Winnipeg the flow is mostly confined to a single bed, although in places it is divided into main and secondary channels, as at the Sepannock channel, due to the generally flat and low-lying nature of the country, and to the consequent ease with which the river can and does, at times, change its bed. In Manitoba the river flows through a low-lying region in which occur innumerable lakes and swamps. Great portions of the surrounding land are subject to floods during periods of high water. In the vicinity of lake Winnipeg the river enters Cedar lake and discharges from this lake into Cross lake, the Demi Charge rapids occurring in this portion of the river. From Cross lake to lake Winnipeg a series of rapids occur comprising the Cross Lake rapids, Red Rock rapids and Grand rapids.

C.—NATURE OF BANKS.

In the vicinity of Le Pas, the banks range from 15 to 25 feet in height, but they become gradually lower as Cedar lake is approached. The shores of this latter lake, as also the banks in the stretch of river to Cross lake, are rocky. From Cross lake to the mouth of the river outcroppings of limestone occur at the water's edge. At Cross Lake rapids this outcrop reaches a height of from 2 to 6 feet. In the vicinity of Red Rock rapids the right bank is composed of limestone of some 6 feet in height, while the left shows no rock outcrops, being composed of clay and of some 12 feet in height. From Red Rock rapids to Grand rapids, the banks which are of clay gradually become higher. At the latter rapids, limestone is again encountered, rising in some places 30 feet above river level. A high ridge of lightly-coloured boulder clay overlying limestone rises to a height of some 60 feet about the mid-point of Grand rapids. This ridge, which forms the barrier between Cedar lake and lake Winnipegosis, crosses the Saskatchewan about three miles above the mouth. Near the foot of Grand rapids a

gully, which was probably at one time an overflow channel, sweeps inland from the left bank and returns to the main river a mile farther down.

D.—WIDTH OF RIVER AND NATURE OF BANKS.

The river in Manitoba has an average width of about 1,000 feet; a minimum width of approximately 500 feet occurs in Grand rapids, widening to 2,400 feet below the rapids. From the Manitoba boundary to Cedar lake the river has a mud-and-gravel bottom, with the occurrence of shifting bars. In the reaches below this section the bed of the river at various rapids is composed of limestone, while many beds of boulders occur in the intervening spaces.

E.—TIMBER AND VEGETATION.

A valuable timber growth occurs a slight distance above Le Pas, but from there to Cedar lake the growth is stunted; and while a dense growth occurs around both Cedar and Cross lakes, yet the timber occurring below this is largely of second growth.

F.—HIGH AND LOW WATER.

High water usually comes during the months of July and August, while low water occurs in the winter months, the river reaching its lowest stage about the month of March. At Le Pas the range between these two periods is ordinarily some 15 feet, while at Grand Rapids the range is gradually lessened, being ordinarily from 4 to 5 feet, with an extreme of some 6 feet. During the spring break-up the field ice of lake Winnipeg occasionally becomes jammed at the mouth of the river, damming the outlet and causing a rise at the lake of from 12 to 15 feet.

G.—NAVIGATION AND ACCESSIBILITY.

The Saskatchewan is navigable above Grand rapids, the Hudson's Bay Co. having at one period run steamers as far upstream as Edmonton. The river at present is navigated by gasolene launches from Le Pas to Cedar lake. It is accessible by railroad at Le Pas, and also by steamer at the mouth.

H.—SETTLEMENTS.

With the exception of Le Pas, no settlements of any size occur in the lower reaches of the river. A Hudson's Bay post is situated at Cedar lake and a small settlement occurs at Grand Rapids.

I.—SURVEYS OF THE RIVER.

In 1884, Dr. Otto Klotz made a traverse of the river. The late R. E. Young made a survey of the settlement in the year 1903 and continued his traverse to the head of Grand rapids, obtaining at the same time a profile of the portage. In 1909 a reconnaissance survey of the river was made from Le Pas to lake Winnipeg by E. A. Forward, of the Public Works Department. The investigations made by the Water-power Branch of the Department of the Interior comprise a reconnaissance power survey by the late William Ogilvie in the year 1911, and in the following year a detailed survey of Grand rapids and vicinity from lake Winnipeg to Cross lake. This latter survey was carried out by E. B. Patterson, in charge of a field party of the Manitoba Power Survey. At the same time a gauging station was established at Grand rapids and discharge measurements were then and have since been obtained at this station.

J.—RUN-OFF.

(*a*) *Precipitation.*—No complete records are available for the precipitation in either the extreme western or eastern portion of the drainage. The following table obtained from the Meteorological records of Canada gives the precipitation at various points throughout the central portion of the drainage, together with some few records of precipitation in the Rocky mountains:—

LENGTH OF RECORD.

Station.	Period.	From.	To.	Depth in inches.
Prince Albert....	9 years	1903	1912	17·13
Saskatoon	9 "	1904	1912	14·45
McLeod........................	22 "	1884	1912	12·58
Calgary....	27 "	1885	1912	15·17
Edmonton......................	28 "	1883	1912	16·43
Banff..........	19 "	1891	1912	20·3
Fort Dunvegan..	4 "	1905	1909	11·5

(*b*) *Discharge Measurements.*—Float discharge measurements were made in the year 1909 by E. A. Forward at Le Pas, and also at Grand rapids. This was followed by measurements made by the late William Ogilvie in the year 1911 at Grand rapids. On August 8, 1912, a gauging station was established at Grand rapids by the Manitoba Hydrographic Survey, and on October 21 of the same year, a second station was established at Le Pas. The results of discharge measurements made at these stations are given in tables No. 72 to 79. It is estimated that for the year 1913, a low flow of 5,000 second-feet occurred during the month of February at Le Pas, and while several lakes and a great area of low-lying swampy land occurs between this point and Grand rapids, which should give some regulation of the flow at the latter point, yet it has been assumed that a minimum flow of 5,000 second-feet also occurred at Grand rapids. During July of 1913 a flood discharge of approximately 64,000 second-feet was recorded at Le Pas.

K.—STORAGE POSSIBILITIES.

Three lakes are situated in the lower portion of the river system immediately above Grand rapids; through two of these lakes—Cedar and Cross lakes—the river flows, while Moose lake is a tributary to the north. The combined area of these three lakes is estimated to be 970 square miles, being made up as follows. Cross lake, 39; Cedar lake, 425; and Moose lake, 513 square miles. While there might be a possibility of storage on these lakes, investigations are at present being made as to the reclamation of low lands in the vicinity of Cedar lake through the lowering of the latter, which, if carried out, would forestall storage possibilities. Investigation is also being made as to the storage possibilities in the head-waters of the Saskatchewan river.

Making the assumption that the flow of the winter months from October 1, 1913, to April 1, 1914, would be similar to the same period during 1912-13, mass curve studies (*see* plate No. 30) show that a storage of 305 billions of cubic feet would be necessary for a uniform flow of 32,000 second-feet. A one-foot storage on Cross, Cedar and Moose lakes would give approximately 27 billion cubic feet, indicating that a storage slightly over 10 feet would be necessary to create a uniform flow for a period similar to that found year ending September 30, 1913.

M.—WATER-POWER.

An estimate of the power available at the three rapids (*see* plate No. 29), is given below. The power available has been based on an 80 per cent efficiency, and is also computed: First, for an estimated minimum flow of 5,000 second-feet; and second, for a flow of 34,000 second-feet, this being the lowest monthly mean flow for the six highest months of the year ending September 30, 1913, and extending from April to September, and the power as indicated refers only to this period.

No estimate has been made as to the additional power available during periods of low flow through any storage system:—

ESTIMATED Horse-power on 80 per cent Efficiency.

Possible Power Site.	Head in feet.	Min. Flow 5000 sec.-ft.	Period 6 mos. April—Sept. 34,000 sec.-ft.
		Horse-power.	Horse-Power.
Demi Charge	15	6808	46289
Red Rock	15	6808	46289
Grand Rapids	80	36305	246877

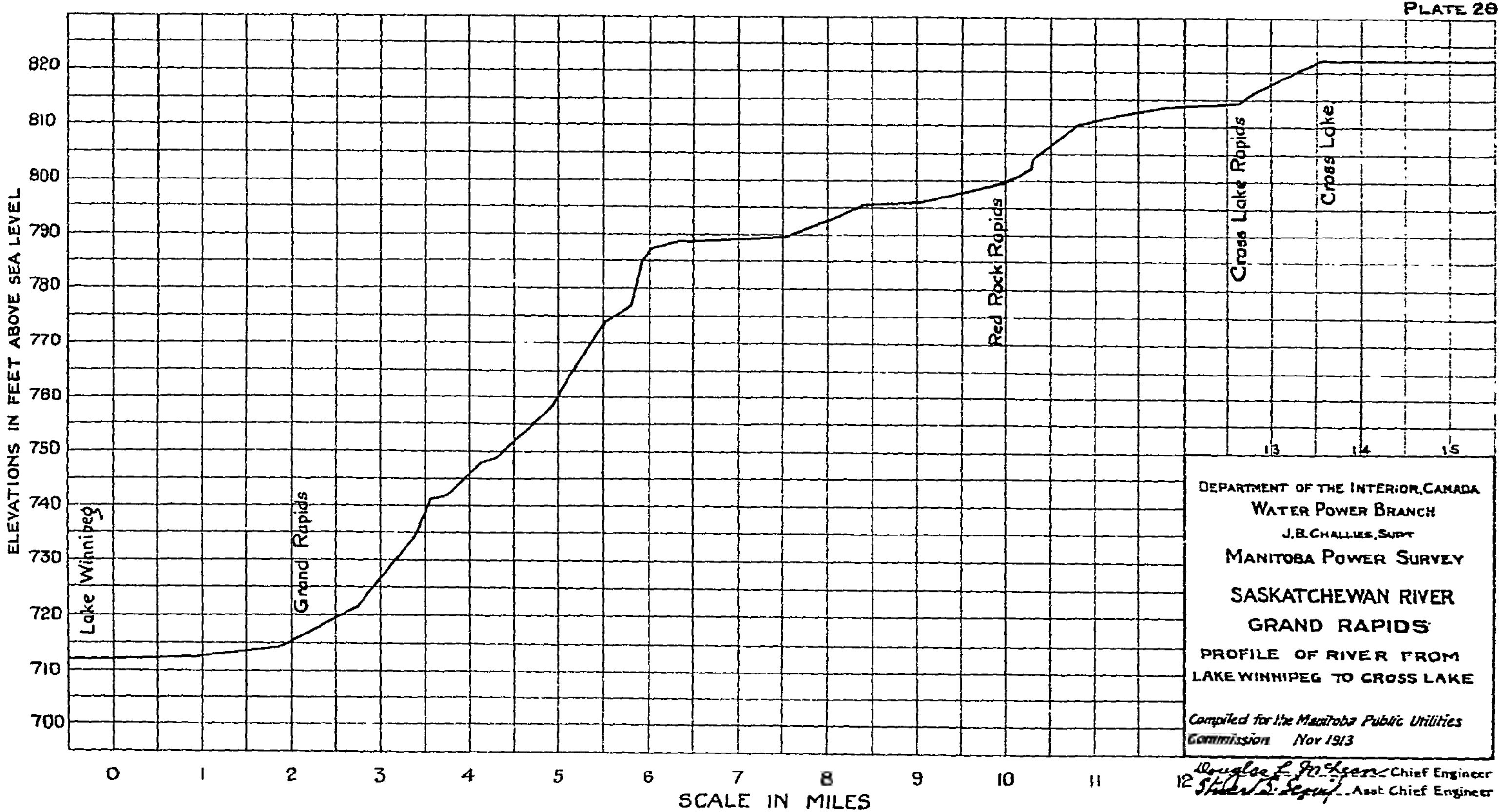
TABLE No. 72.

DISCHARGE MEASUREMENTS of Saskatchewan River, at Le Pas, Man., 1912 and 1913.
TABLE No. 72.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
1912.			Feet.	Sq. ft.	Feet per sec.	Feet.	Sec.-ft.
Oct. 21-22	W. G. Worden	1196	914	18093	2·11	....	38123
Dec. 14	G. J. Lamb	1187	834	12848	0·68	....	[1]8772
1913.							
Feb. 8-9	A. Pirie	1469	771	9563	0·53	....	[1]5105
April 9	"	1186	775	10548	0·72	....	[1]7562
May 31	E. Bankson	1469	761	14233	3 10	9·46	45182
June 4	G. Ebner	1186	750	13331	3·31	9·37	44124
" 10	"	1186	750	13899	3·38	9·79	46979
" 12	"	1186	769	14041	3 51	10·14	49285
" 14	"	1186	739	14197	3·63	10·35	51534
July 10	"	1196	758	15446	3·69	11·98	56948
" 12	"	1196	760	15587	3·58	12·15	57743
" 15	"	1196	756	15848	3·79	12 37	60114
" 18	"	1196	756	16000	3·93	12 58	62883
" 21	"	1196	780	16066	3·98	12·76	63970
" 23	"	1196	673	16107	3·86	12·80	62120
" 25	"	1196	756	16309	3·93	12 91	64199
" 28	"	1196	750	16342	3·91	12·96	63869
" 30	"	1196	756	16332	3·85	12·94	63025
Aug. 1	"	1196	756	16311	3·82	12·85	62385
" 4	"	1196	756	16146	3·81	12·65	62029
" 6	"	1196	756	16043	3·75	12·50	60357
" 28	W. J. Ireland	1469	774	15229	3·62	11·41	55101
Sept. 20	"	1469	729	13422	3·03	8·98	40707
Oct. 9	C. O. Allen	1435	648	11040	2·50	6·07	27532
" 23	"	1435	648	11171	2·15	6 37	[2]24025
Nov. 18	A. Pirie	1496	830	12938	0·92	3·70	[1]11890

1. Ice measurement.
2. Ice running in river.

PLATE 28



ELEVATIONS IN FEET ABOVE SEA LEVEL
820
810
800
790
780
770
760
750
740
730
720
710
700
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
SCALE IN MILES
Lake Winnipeg
Grand Rapids
Red Rock Rapids
Cross Lake Rapids
Cross Lake
DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT
MANITOBA POWER SURVEY
SASKATCHEWAN RIVER
GRAND RAPIDS
PROFILE OF RIVER FROM
LAKE WINNIPEG TO CROSS LAKE
Compiled for the Manitoba Public Utilities Commission Nov 1913
Chief Engineer
Asst Chief Engineer

TABLE No. 73.

DAILY GAUGE HEIGHT AND DISCHARGE, Saskatchewan River, at Le Pas, Man., for 1913.

(Drainage area, 149,500 Square Miles.)

Day.	April. Gauge Height.	April. Discharge.	May. Gauge Height	May. Discharge.	June. Gauge Height.	June. Discharge.	July. Gauge Height.	July. Discharge.	August. Gauge Height.	August. Discharge.	September. Gauge Height.	September. Discharge.	October. Gauge Height.	October. Discharge
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	12·30	60,090	9·45	44,985	11·50	55,850	12·85	63,005	11·35	55,055		
2	....	....	·30	60,090	·40	44,720	·50	55,850	·80	62,740	·24	54,472	....	....
3	....	....	·30	60,095	·30	44,190	·60	56,380	·70	62,210	·16	53,730	....	....
4	....	....	·20	59,560	·40	44,720	·70	56,910	·65	61,945	11·00	53,200	....	....
5	....	....	·24	59,772	·35	44,455	·80	57,440	·60	61,680	10·90	52,670	....	....
6	....	....	12·25	59,825	9·30	44,190	11·80	57,440	12·50	61,150	10·86	52,458	....	....
7	....	....	·20	59,560	·30	44,190	·85	57,705	·50	61,150	·86	52,458	....	....
8	....	....	·40	60,620	·50	45,250	·83	57,599	·40	60,620	·70	51,610	....	....
9	....	....	·60	61,680	·60	45,780	·90	57,970	·30	60,090	·50	50,550	6·30	28,290
10	....	....	·80	62,740	·80	46,840	·90	57,970	·20	59,560	·26	49,278	·12	27,356
11	....	....	11·20	54,260	9·80	46,840	12·00	58,500	12·25	59,825	10·20	48,960	5·95	26,435
12	....	....	·30	54,790	10·00	47,900	·10	59,030	·25	59,825	·00	47,900	5·95	26,435
13	7·2	33,060	·50	55,850	·20	48,960	·40	60,620	12·00	58,500	9·90	47,370	·58	24,474
14	·3	33,590	·60	56,380	·35	49,755	·30	60,090	11 90	57,970	·75	46,575	....	....
15	·4	34,120	·70	56,910	·40	50,020	·40	60,620	·90	57,970	·69	45,780	....	....
16	9 25	43,925	11·50	55,850	10·50	50,550	12·40	60,620	11·90	57,970	9·30	44,190	....	....
17	10·20	48,960	·30	54,790	·60	51,080	·50	61,150	·80	57,440	·17	43,501	....	....
18	·90	52,670	10·20	48,960	·70	51,610	·60	61,680	·70	56,910	·04	42,812	....	....
19	11·20	54,260	·25	49,225	·90	52,670	·60	61,680	·60	56,380	·10	43,130	....	....
20	12·20	59,560	·23	49,119	11·00	53,200	·70	62,210	·50	55,850	·05	42,865	....	....
21	11·65	56,645	10·30	49,490	11·00	53,200	12·80	62,740	11·40	55,320	8·54	40,162	....	....
22	·50	55,850	·20	48,960	·00	53,200	·80	62,740	·40	55,320	·42	39,526	....	....
23	·60	56,380	·00	47,900	·90	57,970	·80	62,740	·35	55,055	·34	39,102	....	....
24	·70	56,910	9·60	45,780	·80	57,440	·80	62,740	·40	55,320	·25	38,625	....	....
25	·90	57,970	·50	45,250	·70	56,910	·90	63,270	·40	55,320	·14	38,042	....	....
26	12 00	58,500	9·55	45,515	11·60	56,380	12·95	63,535	11·40	55,320	7·81	36,293	....	....
27	12·20	59,560	·50	45,250	·50	55,850	·95	63,535	·39	55,267	·74	35,922	....	....
28	·20	59,560	·40	44,720	·50	55,850	·95	63,535	·43	55,479	·20	33,060	....	....
29	·35	60,355	·50	45,250	·50	55,850	13·00	63,800	·40	55,320	....	....	....	....
30	....	....	·50	45,250	·50	55,850	12·90	63,270	·40	55,320	....	....	....	....
31	....	....	·50	45,250	....	....	·90	63,270	·30	54,790	....	....	....	....

TABLE No. 74.

DISCHARGE MEASUREMENTS of Saskatchewan River, at Grand Rapids, Man., 1909.

Date.	Hydrographer.	Width.	Area of Section.	Mean Velocity.	Discharge.
1909.		Feet.	Sq. ft.	Ft. per sec.	Sec.-ft.
				(89·2%.)	
Oct. 21....	F. A. Forward.	876	5711	1·81	21669

NOTE.—Above rapids. No wind. Surface floats. Mean of five good results taken course=1100 ft. Mean time for course=227.4 sec. Surface rate of flow=4.84 ft / sec. Ratio mean to surface flow=89.2 for rough contoured rock bottom. H. W. level six feet above present level. Flood section=1,114 sq. ft. Probable rate of flow=6 ft./sec. The maximum discharge =66,684 sec.-ft.

TABLE No. 75.

DISCHARGE MEASUREMENTS of Saskatchewan River, at Grand Rapids, Man., 1910.

Date.	Hydrographer.	Meter No.	Width.	Area of Section.	Mean Velocity.	Gauge Height.	Discharge
1910.			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
July......	Wm. Ogilvie.	......	1018	13341	2·65	786·22	35322
Oct.....	Wm. Ogilvie.	....	....	....	....	....	24433

NOTE.—Taken on section late used by W.P.S. Approximative elevation of gauge=786.22.

TABLE No. 76.

DISCHARGE MEASUREMENTS of Saskatchewan River, at Grand Rapids, Man., 1912.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Aug. 8........	E. B. Patterson....	285	1,055	15,061	3·47	788·18	52,262
Sept. 18........	E. B. Patterson.....	3	1,056	15,853	4·01	788·96	63,570
" 23........	E. B. Patterson.....	3	1,058	15,957	3·98	789·06	63,510

TABLE No. 77.

Discharge Measurements of Saskatchewan River, at Grand Rapids, Man., 1913.

Date.	Hydrographer.	Meter No.	Width.	Area of section.	Mean velocity.	Gauge height.	Discharge.
			Feet.	Sq. ft.	Ft. per sec.	Feet.	Sec.-ft.
Aug. 27	A. Pirie	1,496	1,054	15,422	3·71	788·31	57,206
" 29	A. Pirie	1,497	1,054	15,485	3·57	788·36	55,266
" 30	A. Pirie	1,497	1,054	15,427	3·55	788·29	51,718
Nov. 10	A. Pirie	1,496	1,016	11,872	1·66	786·01	19,727
" 11	A. Pirie	1,496	1,012	11,963	1·71	785·97	20,548

TABLE No. 78.

Daily Gauge Height and Discharge, Saskatchewan River, near Head of Grand Rapids, for 1912.

Day.	August.		September.		October.		November.	
	Gauge height.	Discharge.	Gauge height.	Discharge.	Gauge height	Discharge.	Gauge height.	Discharge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1	....	....	788·79	62,000	....	65,000	....	38,750
2	....	....	·84	62,750	....	65,000	....	38,750
3	787·88	48,500	·80	62,000	....	65,000	....	38,750
4	....	49,000	·74	61,250	....	65,000	787·23	38,750
5	787·93	49,250	·77	61,250	....	65,000	....	38,750
6	788·00	50,000	788·89	63,500	....	65,000	....	37,250
7	·04	50,750	789·11	66,500	789·02	65,000	....	35,750
8	·13	52,250	....	66,250	....	66,500	....	34,250
9	·21	53,000	....	66,000	....	68,000	....	32,750
10	....	51,500	789·06	65,750	....	69,500	....	31,250
11	....	50,000	788·99	65,000	....	71,000	786·67	29,750
12	....	48,500	·99	65,000	....	72,500	....	29,000
13	....	47,000	789·07	65,750	....	74,000	....	28,250
14	787·82	47,000	788·96	64,250	789·60	74,000	....	27,500
15	....	47,000	·98	65,000	....	74,000	....	26,750
16	....	47,000	788·99	65,000	....	74,000	....	26,000
17	....	47,750	·94	64,250	....	74,000	....	25,250
18	....	47,750	·96	64,250	....	72,500	786·28	24,500
19	787·83	47,750	·98	65,000	....	72,500	....	24,500
20	....	47,750	789·01	65,000	....	72,500	....	24,500
21	....	47,000	788·99	65,000	789·50	72,500	....	23,750
22	787·79	47,000	789·01	65,000	....	67,250	....	23,750
23	....	50,750	·10	66,500	....	62,000	....	23,000
24	....	54,500	·06	65,750	....	56,750	....	23,000
25	....	57,500	788·96	64,250	....	51,500	786·22	23,000
26	788·74	61,250	....	64,250	....	46,250	....	....
27	....	61,250	....	64,250	....	41,000	....	....
28	....	61,250	....	64,250	787·29	39,500	....	....
29	....	61,250	....	64,250	....	39,500	785·45	....
30	....	62,000	....	64,250	....	39,500	....	....
31	....	62,000	....	....	....	39,500	....	....

TABLE No. 79.

DAILY GAUGE HEIGHT AND DISCHARGE, Saskatchewan River, near Head of Grand Rapids, Man., for 1913.

Day.	May.		June.		July.		August.		September.		October.		November.	
	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.	Gauge Height.	Dis-charge.
	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.	Feet.	Sec.-ft.
1				48,500		46,500		54,500		53,000		39,950		24,500
2			787·89	48,500		46,500		54,500	788·19	53,000		39,500		23,900
3				48,500		46,500		54,500		52,550		39,050		23,300
4				48,500		47,500	788·29	54,500		52,100		38,600		22,700
5				47,500		47,500		54,500		51,650		38,150		22,100
6				47,500		47,500		54,500		51,200		37,700		21,500
7				46,500	787·89	48,500		54,500		50,750		37,250	786·12	21,500
8				46,500		48,500		56,000		50,300		36,800	·06	20,750
9			787·69	45,500		48,500		56,000		49,850		36,350	25	23,750
10				45,500		48,500		56,000		49,400		35,900	785·95	19,250
11				45,500		47,000	788·39	56,000		48,950		35,450	785·96	19,250
12				45,500		47,000		56,000		48,500		35,000	·01	
13				45,500		47,000		56,000		48,050	786·99	35,000	·06	
14				45,500	787·79	47,000		56,000		47,600	·97	34,250	784·95	
15				45,500		48,000		54,500		47,150	·96	34,250	·78	
16			787·69	45,500		49,000		54,500		46,700	786·92	33,500		
17				45,500		50,000		54,500		46,250		33,500		
18				45,500		51,000	788·29	54,500		45,800		32,900		
19	786·99	35,000		45,500		52,000		54,500		45,350		32,300		
20		37,250		45,500		53,000		55,250		44,900		31,700		
21		39,500		45,500	788·28	54,500		55,250		44,450		31,100		
22		41,750		45,500		54,500		56,000		44,000		30,500		
23		44,000	787·69	45,500		54,500		56,000		43,550		29,900		
24		46,250		45,500		54,500		56,000		43,100		29,300		
25		48,500		45,500		56,000		56,750		42,650		28,700		
26	787·99	50,000		45,500		56,000	788·45	56,750		42,200		28,100		
27		50,000		45,500		56,000	788·33	55,250		41,750		27,500		
28		50,000		45,500	788·39	56,000		55,250		41,300		26,900		
29		50,000		45,500		56,000	788·33	56,000		40,850		26,300		
30		48,500	787·69	45,500		56,000	·31	54,500		40,400		25,700		
31		48,500				56,000		54,500				25,100		

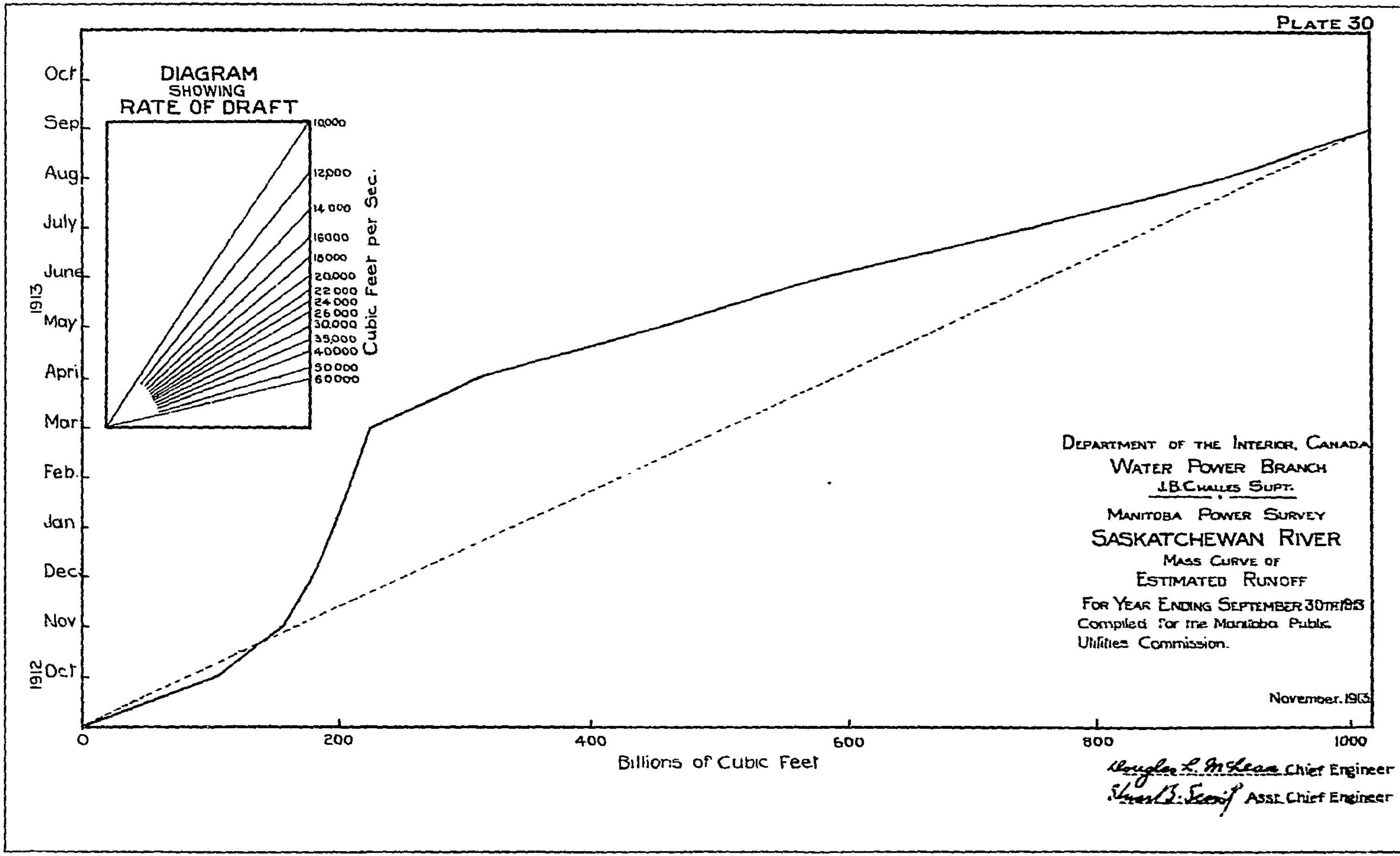
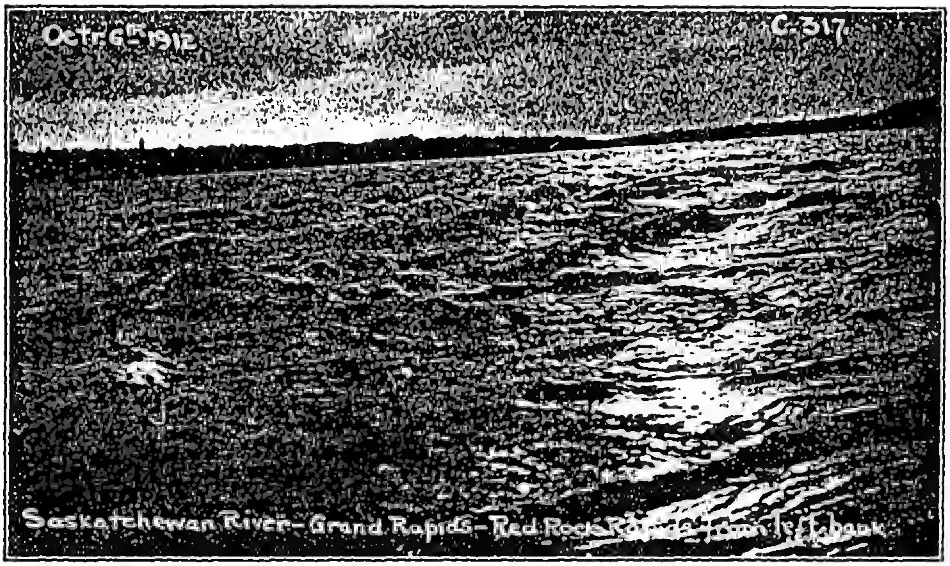
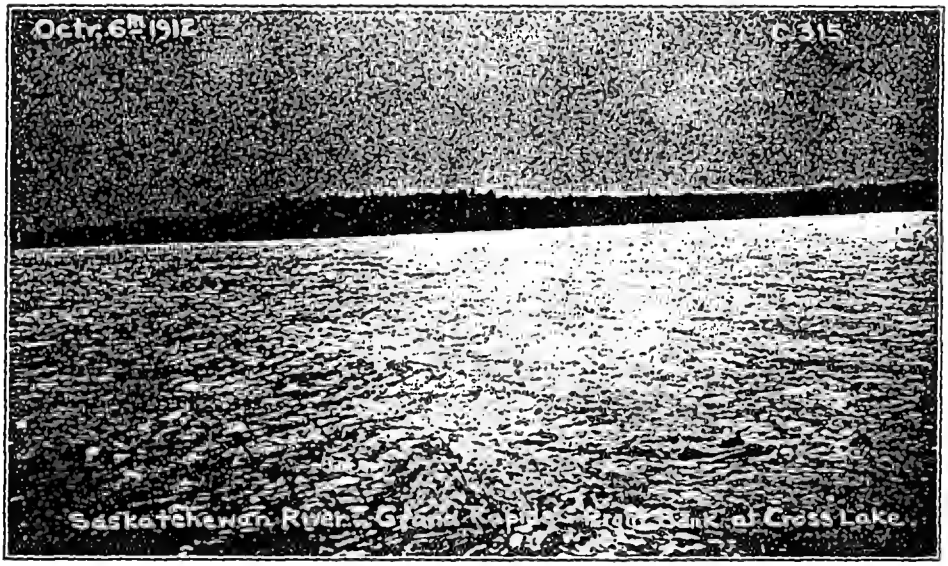
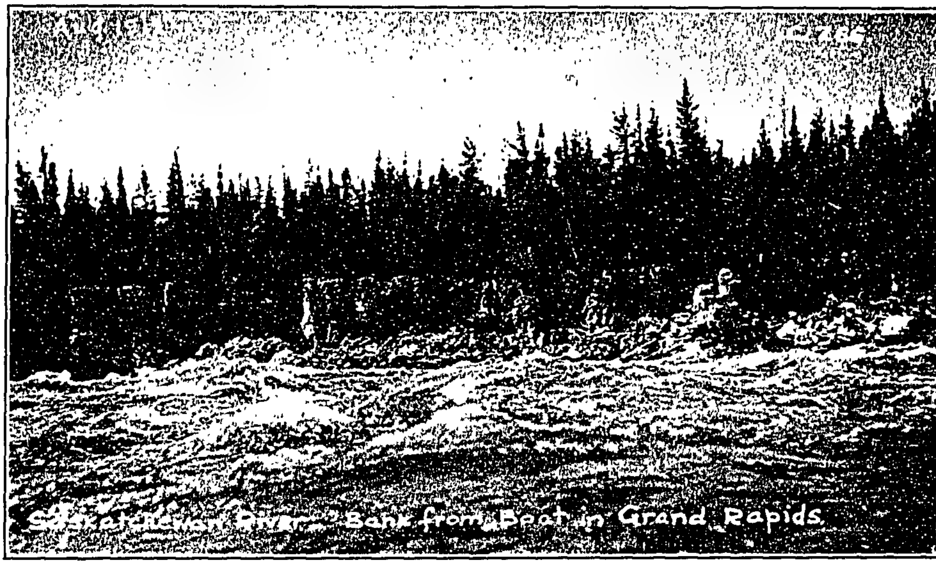


PLATE 30
DIAGRAM
SHOWING
RATE OF DRAFT
10,000
12,000
14,000
16000
18000
20,000
22,000
24,000
26,000
30,000
35,000
40000
50000
60000
Cubic Feet per Sec.
Oct
Sep
Aug
July
June
1913
May
April
Mar
Feb.
Jan
Dec
Nov
1912
Oct
0
200
400
600
800
1000
Billions of Cubic Feet
DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES SUPT.
MANITOBA POWER SURVEY
SASKATCHEWAN RIVER
MASS CURVE OF
ESTIMATED RUNOFF
FOR YEAR ENDING SEPTEMBER 30TH 1913
Compiled for the Manitoba Public
Utilities Commission.
November. 1913
Douglas L. McLean Chief Engineer
Asst. Chief Engineer


Octr. 6th 1912
C.317
Saskatchewan River - Grand Rapids - Red Rock Rapids from left bank


Octr. 6th 1912
C.315
Saskatchewan River - Grand Rapids - From bank at Cross Lake.



Saskatchewan River — Bank from Boat in Grand Rapids

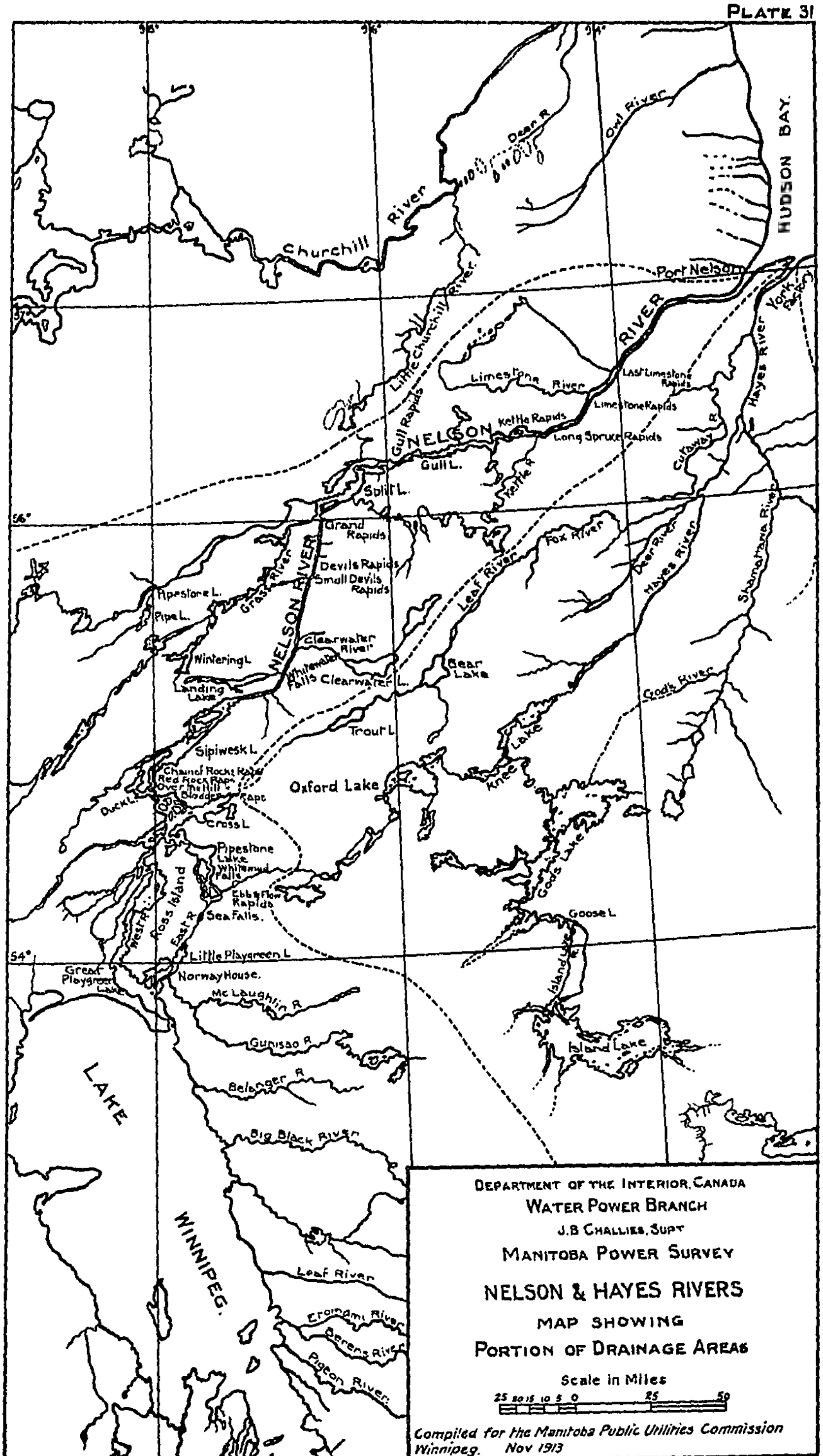
Saskatchewan River—Le Pas. Shewing H.W.M. 1901 + 1908.

WATER-POWERS OF MANITOBA

CHAPTER VIII

RIVERS IN NORTHERN PORTION OF MANITOBA

PLATE 31



Douglas L. McLean Chief Engineer
Stuart S. Scovil Asst. Chief Engineer

CHAPTER VIII

RIVERS IN NORTHERN PORTION OF MANITOBA

NELSON RIVER.

A.—LOCATION.

The Nelson river (*see* plate No. 31) flows through the central portion of northern Manitoba. Heading in the northerly end of lake Winnipeg, the river flows in a general northeasterly direction, discharging into the southwest corner of Hudson bay.

B.—RIVER BASIN.

The Nelson river, being the outlet of lake Winnipeg, discharges the waters collected by this lake from an immense drainage area. It is one of the first or main drainage systems of the northern continent, having a tributary area of some 450,000 square miles. This vast area extends from the height of land slightly west of lake Superior to the Rocky mountains. To the north, the basin is bounded by the Athabaska and Churchill rivers, while the southern drainage extends down into the Northern States. Rivers tributary to lake Winnipeg and having immense areas of tributary drainage in themselves, comprise such systems as the Winnipeg, Red, Dauphin and Saskatchewan rivers. Numerous smaller rivers, including the Berens, Pigeon, Manigotagan and Brokenhead also contribute to the flow from lake Winnipeg.

Practically a complete range of physical characteristics or conditions is found throughout the basin, comprising as it does the drainage from the eastern slopes of the Rocky mountains and ranging from this to the prairie section of Western Canada, and again farther eastward to the rocky and hummocky country of the Laurentian Plateau. Similarly, there is a vast difference in the nature of the vegetation and forest growth.

The drainage directly tributary to the Nelson is small in extent as compared to that tributary to lake Winnipeg, but it includes the following rivers: Burntwood, Limestone, Kettle and several smaller streams.

Due to the tremendous expanse of lake Winnipeg and of its tributary systems of great lakes, comprising lakes Manitoba and Winnipegosis, practically a natural regulation of the flow of the Nelson river results, and the range between flood and minimum discharge cannot be high. In this respect, the Nelson river is similar to the St. Lawrence, in that the flow of the latter has a natural regulation through the action of the Great lakes.

C.—GENERAL DESCRIPTION OF RIVER.

The length of the river from lake Winnipeg to Hudson bay, as determined by a survey made by Dr. Otto J. Klotz, is 430 miles. In this distance a drop of some 700 feet occurs. In the upper reaches, the river could more properly be described as a chain of lakes connected by falls or by reaches of river and rapids. In this upper portion of the river extending approximately, to Split lake, some 250 miles from lake Winnipeg, the banks are in general higher than found on the lower portion. Although

the river, as stated, expands in this upper section into many lakes of practically ponded or of slow-running water, yet the falls are more sharply defined and usually of steeper descent than found in the lower reaches, and at the same time are often separated by islands into numerous narrow channels. Not only are the banks lower as lake Winnipeg is approached, but the distance between them becomes greater. The descent, also, is not so abrupt, being more often a series of rapids or swift running water. These latter characteristics gradually become more accentuated as Hudson bay is approached.

Expanding into Playgreen lake a short distance below lake Winnipeg, the river flows from the former lake through two main branches separated by Ross island, and known as the East and West rivers. The East river, on which occurs Sea River falls, is narrowed at many points by islands, although later it expands into Pipestone lake. The West river is wider and is navigable by steamboat to Whisky Jack portage, which is in the vicinity of the junction of the two branches at Cross lake. From this lake to Sepewesk lake, the river at first flows between islands and drops through the Ebb and Flow rapids, followed by the Whitemud falls. The Bladder rapids follow, in which the river flows in one narrow channel. Below this rapids, the river again divides into two main channels before lake Sepewesk is reached. On the eastern channel, three rapids are met with; Over the Hill, Red Rock and Chain of Rock rapids. Below Sepewesk lake to the Manitou or Devils rapids, the river is more contracted and retains this feature until it reaches Split lake. In the reaches above this lake is Grand rapids, followed very closely by Chain of Islands rapids. Birthday or Overfall rapids follows in the stretch of river to Gull lake. Below this latter lake, the river expands and is divided by islands with the formation of Gull, Kettle and Long Spruce rapids. From Long Spruce rapids to Hudson bay, in which stretch the Limestone rapids occurs, the river is generally wider and freer of islands.

D.—NATURE OF BANKS.

Throughout the extent of the river, rock outcrops are stated to occur at practically all rapids. The soil overlying the rock is principally clay, with some deposits of gravel and boulders. The banks at the location of rapids range in height from some 10 to 70 feet in the upper portion of the river, but become generally lower as the mouth of the river is approached.

E.—TIMBER AND VEGETATION.

A scattered growth of timber, including spruce, birch and poplar occurs along the river. The clay soil overlying the rock formation is stated to be very fertile, and root crops are grown at Norway House, Cross lake and Split lake. Wheat is also stated to have been grown at the two former places.

F.—HIGH AND LOW WATER.

High water is stated to take place during mid-summer, while the period of low water is usually in the late winter months. It is also stated that the extreme range between these two periods is never more than six feet.

G.—TRANSPORTATION.

Steamboats at present navigate the Nelson river from lake Winnipeg to Whisky Jack portage, but below this point navigation is only possible in certain portions of the river. The river is not crossed at any point by railroad, but at several points is in the vicinity of the new Hudson Bay railway.

H.—SURVEYS OF THE RIVER.

Numerous surveys of the river have been made for various purposes. In the year 1878, Dr. Robert Bell made a geological survey from lake Winnipeg to the mouth of the river. A similar survey was made in the year 1902 by Mr. J. B. Tyrrell of the Geological Survey. In the interests of navigation, a reconnaissance survey was made by the Department of Public Works of Canada in the fall of 1909. From the report on this work, considerable data, including a profile of the river, has been obtained for the present report. Surveys carried on by the Water Power Branch of the Depart- of the Interior, include a reconnaissance of the power possibilities of the upper portion of the river, by the late William Ogilvie in the year 1910, and also discharge measurements of the East and West rivers during the season of 1913.

I.—RUN-OFF.

(a) *Rainfall.*—As no rainfall records are available for the greater portion of the drainage area, it would be impossible to estimate what the mean for the whole area would be. The following table gives the mean annual rainfall for certain stations lying within the basin. It will be noted that there is a wide range in the precipitation.

Station	Period of Record		Term in Years	Precipitation in Inches
	From	To		
Winnipeg, Man.	1873	1912	40	21·6
Kenora, Ont.	1886	1912	9	22·4
Channel Island (Lake Winnipeg)	1890	1903	13	17·1
Norway House, Man.	1896	1904	8	18·9
Moorhead, Minn.	1881	1908	28	21·9
Prince Albert, Sask.	1903	1912	9	17·1
Edmonton, Alta.	1883	1912	28	16·4
Calgary, Alta.	1886	1909	23	18·6
McLeod, Alta.	1896	1912	15	13·6
Banff, Alta.	1891	1912	19	20·3

(b) *Discharge Measurements.*—Some few miscellaneous discharge measurements have been made on the Nelson river, though none of these measurements, however, apparently determine the low flow of the river. Discharge measurements made by Mr. William Ogilvie in the latter part of August, 1910, in the vicinity of Whitemud walls, indicate a discharge of 109,364 second-feet. Mr. Miles, of the Department of Public Works, obtained a discharge measurement at the outlet of Sepewesk lake on October 6, 1909, at what was stated to be a very low stage of the river, this resulting in a flow of 118,369 second-feet. In September, 1913, measurement of the flow of the East and West rivers were made by Alexander Pirie of the Manitoba Hydrographic Survey. On September 16, 1913, the total flow of the East river below Sea River falls was 19,762 second-feet. On September 25, the flow on the West river in the vicinity of Whisky Jack portage was 46,549 second-feet. At the time of metering the West river a storm from the northwest lowered the level of lake Winnipeg at its northerly end which undoubtedly greatly decreased the flow.

J.—STORAGE POSSIBILITIES.

As stated previously, any extreme variation in the flow of the Nelson river is hardly possible, due to the immense expanse of lake area at the head of the river. The vast area of lake Winnipeg offers unexcelled facilities for a storage which should

completely regulate the flow of the river. The lake comprises an area of 9,414 square miles, and in extent ranks fifth in superficial area of the lakes of North America; it is over 2,000 square miles larger than lake Ontario and slightly less than lake Erie. The following table gives an estimate of the flow which a storage of only 2 feet would render available for periods of either 3 months, 6 months or a year:—

Depth of Storage	Storage in Billions of Cu. Ft.	Rate of Draft in second-feet.		
		Period 3 Months	Period 6 Months	Period 1 Year
1 foot........	262·30	33·260	16·630	8315
2 "	521·60	66·520	33·260	16630

K.—WATER-POWER.

The following table gives an estimate of power available on the Nelson river at various points of concentration (*see* plate No. 32). As no detailed investigation of the river's power possibilities has as yet been made, the head available is subject to revision. The estimate has been based on a minimum flow of 50,000 second-feet, computed for an efficiency of 80 per cent. The estimate of minimum flow is also subject to verification or revision as future records of the Manitoba Hydrographic Survey will show. No estimate has been made for the additional power available through regulated flow from lake Winnipeg:—

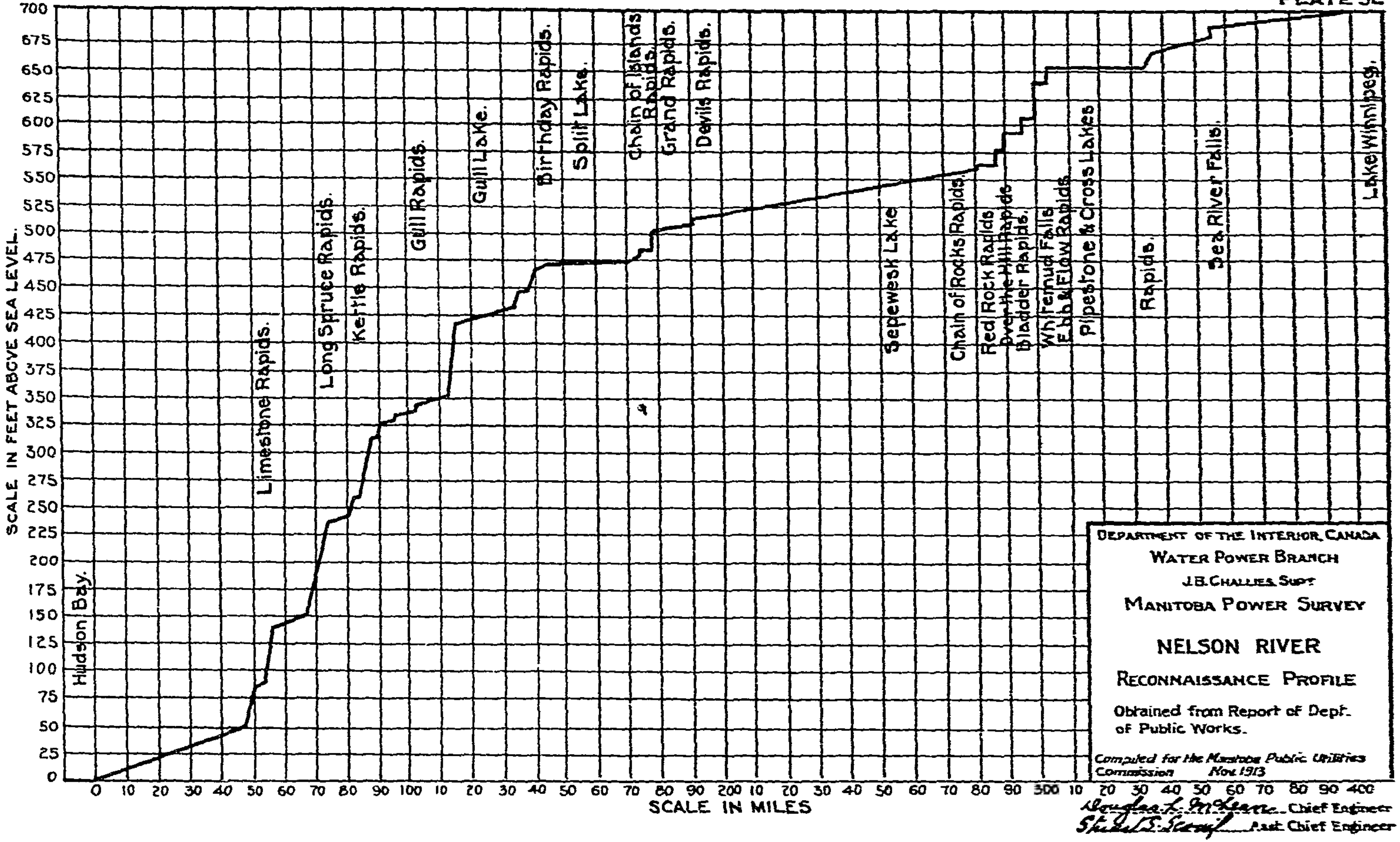
Possible Power Site.	Heads.	Estimated Horse-power based on minimum flow of 50,000 second feet at 80 per cent efficiency.
	Feet.	Horse-power.
Whisky Jack portage..........	40	181,150
Ebb and Flow rapids..........	17	77,150
White Mud rapids..........	30	135,860
Bladder..........	20	90,575
Chain of Rocks rapids..........	35	158,510
Devils rapids..........	25	113,220
Grand rapids..........	27	122,530
Birthday rapids..........	36	163,375
First Gull rapids..........	17	77,150
Second " rapids..........	21	95,105
Third " rapids..........	20	90,575
Fourth " rapids..........	30	135,860
First Kettle rapids..........	17	77,150
Second " rapids..........	21·5	97,370
Third " rapids..........	40	181,150
Upper Long Spruce rapids..........	40	181,150
Lower Long Spruce rapids..........	52	235,495
Upper Limestone rapids..........	33	149,450
Lower Limestone rapids..........	41	185,680
Total..........		2,518,505

Hayes River.

A.—LOCATION.

The Hayes river (*see* plate No. 31) is situated in the central portion of northern Manitoba. Rising slightly to the east of the northerly end of lake Winnipeg, the river flows in a northerly direction, discharging into Hudson bay.

PLATE 32



Hudson Bay.
Limestone Rapids.
Long Spruce Rapids.
Kettle Rapids.
Gull Rapids.
Gull Lake.
Birthday Rapids.
Split Lake.
Chain of Islands Rapids.
Grand Rapids.
Devils Rapids.
Sepewesk Lake
Chain of Rocks Rapids.
Red Rock Rapids
Over the Hill Rapids
Bladder Rapids.
Whitemud Falls
Ebb & Flow Rapids
Pipestone & Cross Lakes
Rapids.
Sea River Falls.
Lake Winnipeg.
SCALE IN FEET ABOVE SEA LEVEL.
SCALE IN MILES
DEPARTMENT OF THE INTERIOR, CANADA
WATER POWER BRANCH
J.B. CHALLIES, SUPT
MANITOBA POWER SURVEY
NELSON RIVER
RECONNAISSANCE PROFILE
Obtained from Report of Dept. of Public Works.
Compiled for the Manitoba Public Utilities Commission Nov 1913
Chief Engineer
Asst. Chief Engineer

B.—RIVER BASIN.

The Hayes river drains a basin 36,250 square miles in extent, which lies between the drainage of the Nelson and Severn rivers. The first fifteen miles of the lower portion of the river could more properly be called an inlet of Hudson bay, as very little drop is stated to take place in this distance. Some 6 miles above this inlet, the junction of the Nelson and Cutaway rivers occurs, while some 35 miles further upstream there enters a tributary, known as the Shamattawa river, which in extent is practically of the same size as the Hayes. The Shamattawa river could more properly be stated to comprise in its source the head-waters of the drainage. While the Shamattawa carries the drainage from the country east of the Hayes river, the Fox river, entering some 40 miles above, drains the western portion of the area. Between these two rivers lies the Hayes river itself, which discharges several large lakes lying in the vicinity of the northern end of lake Winnipeg. The basin is dotted with many lakes varying in size from small ponds to lakes of large extent, such as Oxford lake, Gods lake and Island lake. The upper portion of the watershed in which these lakes are located is stated to be broken and hilly with the occurrence of many rock outcrops.

C.—GENERAL DESCRIPTION OF RIVER AND BASIN.

From the outlet to the mouth of the Fox river, the Hayes is comparatively wide, with shallow water, and for the most part low banks, although the latter increase in height at some few places. In the reach of the river extending some 35 miles above Fox river the banks become gradually higher, and the river has a uniform width of about 250 feet. It is stated that four rapids of gradual descent are located in this stretch of river. Many rapids with a fall of from 3 to 6 feet each occur above this, in that portion of the river below Knee lake. Above Knee lake the Hayes river consists of a chain of lakes connected by short stretches of very swift water, often broken by rapids or falls.

D.—TIMBER AND VEGETATION.

Along the main river the land is stated to be of good clay soil, with a varied growth of poplar and spruce, while at Oxford House, in the vicinity of Oxford lake, excellent cereal and root crops are grown.

E.—SETTLEMENTS.

There are two small settlements in the drainage basin, one being at York Factory, situated at the mouth of the river, while the other is at Oxford House on the north-east shore of Oxford lake.

F.—RUN-OFF.

(a) *Precipitation.*—No records of precipitation are available for the drainage area, but it is estimated that there is a mean annual precipitation of some 19 inches, this latter being based on an eight-year record at Norway House, which is situated at the northerly end of lake Winnipeg.

(b) *Discharge Measurements.*—No discharge measurements of the total flow of this river have as yet been made. Assuming the mean annual run-off of 0·3 second-feet per square mile for a drainage area of 36,250 square miles would give a mean annual discharge of 10,875 second-feet. No estimate is made as to the minimum flow of this river, but considering the great extent of lake area lying within the basin, the range between flood and minimum flow should not be great.

G.—WATER-POWER.

While no detailed investigations have as yet been made of the power available on this river, yet it is stated that at many points in the river there is a possibility of power concentrations. The elevation of Island lake lying at the head-waters of the Shamattawa river is stated to be 900 feet above sea-level, which would indicate a drop of this extent ocurring between the head-waters and the mouth. In the reaches of the river above the junction of the Fox and extending to the upper lakes, the average descent is stated to be over 8 feet per mile, and it is in this section of the river that the banks are of sufficient height to permit of power concentration at many points.

CHURCHILL RIVER.

A.—LOCATION.

The Churchill river (*see* plate No. 33) flows in an easterly direction across the western provinces until the Manitoba boundary is reached. At this point the river bends to the north and the course through Manitoba is in this latter direction to the mouth of the river on the southwestern shore of Hudson bay.

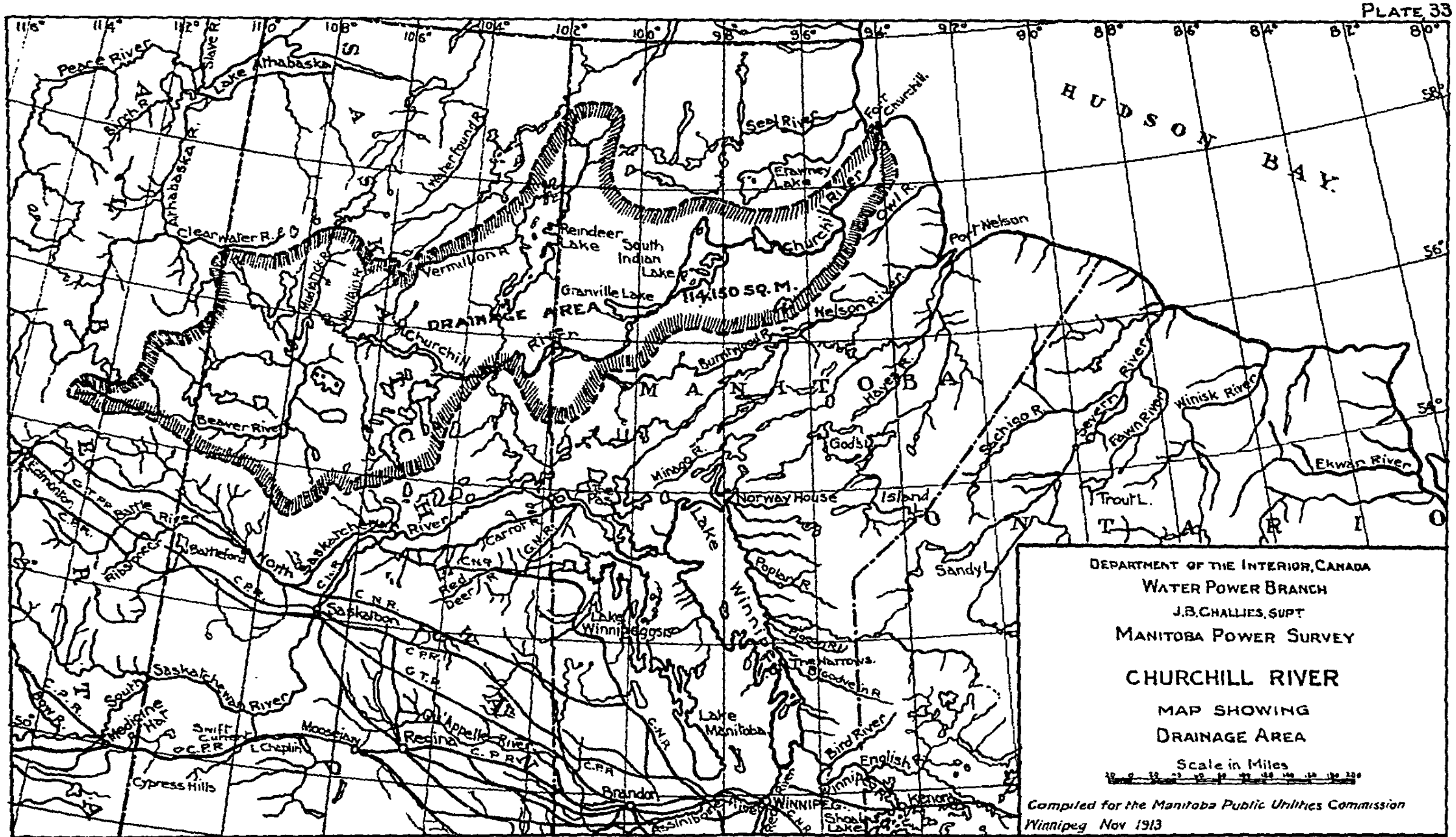
B.—RIVER BASIN.

The basin drained by the Churchill is 114,150 square miles in extent. It lies to the north of the Saskatchewan drainage and heads in the vicinity of the Athabaska river. In the lower reaches in the vicinity of Hudson bay the river is situated to the north of the Nelson river and roughly parallels the course of the latter. The general nature of the basin is altogether the opposite of that found in the lower region drained by the Saskatchewan. Innumerable lakes of varying size occur throughout the whole basin, and a great portion of the river itself could more properly be described as a chain of lakes joined by short stretches of river, or in some cases only by a fall from one lake to another. Due to the occurrence of these many lakes and the angles at which the flow passes through them, the river presents a very irregular appearance. Of the main streams tributary to the Churchill, those entering from the north comprise the Reindeer river, which heads in Reindeer lake, and which is practically the largest lake throughout the basin, and, in itself, has considerable tributary drainage comprising many smaller lakes. Above the junction of this river there enters the Trout, Foster, Haultain and Mudjatik rivers, together with many smaller streams. The Churchill itself heads in Ile à la Crosse lake, tributary to which and lying to the north are Buffalo and Cedar lakes, into the former of which lake la Loche is drained by la Loche river. A second tributary entering the southerly end of Ile à la Crosse heads in several small lakes which constitute the extreme head-waters of the drainage and are situated in the vicinity of Lac la Biche in the province of Alberta. The main tributaries entering the Churchill from the south and below the Beaver river, are the Sandy, Montreal, Burntwood and Little Churchill rivers. Practically all the tributaries to the Churchill either discharge from or through numerous lakes of varying size, and throughout the basin many rapids and falls occur.

In the southern portion of the drainage, large areas of good agricultural clay are stated to be overlying the rock formation, but to the north the extent of the rock outcrop increases greatly.

From Fort Churchill, situated at the mouth of the river, for approximately 80 miles upstream the Churchill is stated to be free from formidable rapids, the banks in this stretch being of clay and, at places, both high and steep. Above this to North Indian lake, which is situated about midway in the course of the river through

PLATE 33



Douglas L. McLean Chief Engineer
Samuel S. Scovil Asst. Chief Engineer

Manitoba, the river widens out at two points, into two small lake expanses. Numerous rapids occur in this stretch. Some 30 miles west of North Indian lake the river discharges through South Indian lake with two rapids in the intervening reach. A short distance above the southern lake, the river again widens into Granville lake, followed a short distance upstream by Nelson lake and again by Puklatawagan. Loon and Sissipuk lakes, the latter lake being situated approximately on the Manitoba boundary.

C.—SETTLEMENTS.

No extensive settlements are situated in the vicinity of the river, though there are many trading posts and missions scattered throughout the district.

D.—NAVIGATION AND ACCESSIBILITY.

The Churchill is stated to be navigable only by canoe, due to the many rapids necessitating portages, yet is acessible at the mouth by steamer from Hudson bay. No railroads are situated in the immediate vicinity of the river.

E.—WATER-POWER.

As a power possibility the Churchill river offers a magnificent field for investigation. While no survey of this nature has yet been made of either the portion in Manitoba or in the reaches outside the province, it is known that considerable fall occurs throughout the extent of the river. Reindeer lake, which is drained by Reindeer river, a tributary to the Churchill some 60 miles west of the Manitoba boundary, is at an elevation of 1,150 feet above sea-level, indicating a drop of that extent between the above-mentioned lake and the mouth of the river. Ile à la Crosse in the vicinity of the head-waters is at an elevation of 1,330 feet, while Knee lake, a considerable distance to the eastward, is 1,250 feet above sea-level. Not only is there an indication of considerable fall on the river, but also the numerous and extensive lake areas indicate, not only great natural regulation of the flow, but also the possibilities of further regulation through systems of storage on some of the larger lakes.

No discharge measurements have as yet been made on this river, nor is there anything definite known as to the precipitation. Assuming, however, a mean annual runoff of 0·3 second-feet per square mile, this would give a mean annual discharge of some 34,000 second-feet.

WATER-POWERS OF MANITOBA.

CHAPTER IX.

REGULATIONS GOVERNING THE GRANTING OF WATER-POWER PRIVILEGES

IN

MANITOBA, SASKATCHEWAN, ALBERTA AND THE NORTHWEST TERRITORIES

CHAPTER IX.

WATER-POWER REGULATIONS UNDER THE DOMINION LANDS ACT, SEC. 35, S.S. 2.

REGULATIONS made by His Excellency the Governor General in Council in virtue of the provisions of subsection 2 of section 35 of the Dominion Lands Act, 7-8 Edward VII, chapter 20, as amended by section 6 of chapter 27, 4-5 George V, to govern the mode of granting water-power rights in the provinces of Manitoba, Saskatchewan and Alberta, and the Northwest Territories.

Section 35, Dominion Lands Act.—Water-power.

35. Lands which are necessary for the protection of any water supply or lands upon which there is any water-power, or which border upon or being close to a water-power will be required or useful for the development and working of such water-power, shall not be open to entry for homestead, for purchased homestead, or pre-emption, or be sold or conveyed in fee by the Crown, but may only be leased under regulations made by the Governor in Council.

(2) Subject to rights which exist or may be created under the Irrigation Act, the Governor in Council may make regulations: (*a*) for the diversion, taking or use of water for power purposes, and the granting of the rights to divert, take and use water for such purposes, provided that it shall be a condition of the diversion or taking of water that it shall be returned to the channel through which it would have flowed if there had been no such diversion or taking, in such manner as not to lessen the volume of water in the said channel; (*b*) for the construction on or through Dominion or other lands or sluices, races, dams or other works necessary in connection with such diversion, taking or use of water; (*c*) for the transmission, distribution, sale and use of power and energy generated therefrom; (*d*) for the damming of and diversion of any stream, watercourse, lake or other body of water for the purpose of storing water to augment or increase the flow of water for power purposes during dry season; (*e*) for fixing the fees, charges, rents, royalties or dues to be paid for the use of water for power purposes, and the rates to be charged for power or energy derived therefrom.

(3) Any person who under such regulations is authorized to divert, take or use water for power purposes, or to construct works in connection with the diversion, taking or use of water for such purposes, shall for the purposes of his undertaking have the powers conferred by the Railway Act upon railway companies, including those for the acquisition and taking of the requisite lands, so far as such powers are applicable to the undertaking and are not consistent with the provisions of this Act or the regulations thereunder, or with the authority given to such persons under such regulations—the provisions of the said Railway Act giving such powers being taken for the purposes of this section to refer to the undertaking of such person where in that Act they refer to the railway of the railway company concerned.

(4) All maps, plans and books of reference showing lands other than Crown land necessary to be acquired by any such person for right of way or other purposes in connection with his undertaking shall be signed and certified correct by a duly qualified Dominion Land Surveyor.

(5) Such maps, plans and books of reference shall be prepared in duplicate and one copy thereof shall be filed in the office of the Minister at Ottawa, and the other shall be registered in the land titles office for the registration district within which the lands affected are situated.

(6) The Minister, or such officer as he designates, shall in case of dispute be the sole and final judge as to the area of land which may be taken by any person without the consent of the owner for any purpose in connection with any water-power undertaking.

REGULATIONS GOVERNING THE GRANTING OF WATER-POWER RIGHTS IN THE PROVINCES OF MANITOBA, SASKATCHEWAN AND ALBERTA, AND THE NORTHWEST TERRITORIES.

(Established by Orders in Council dated June 2, 1909, June 8, 1909, April 20, 1910, January 24, 1911, and August 2, 1913.)

1. Under these regulations the word 'works' shall be held to mean and include all sluices, races, dams, weirs, tunnels, pits, slides, flumes, machines fixed to the soil, buildings and other structures for taking, diverting and storing water for power purposes, or for developing water-power and rendering the same available for use.

MODE OF APPLICATION.

2. Every applicant for a license to take and use water for power purposes shall file with the Minister of the Interior a statement in duplicate setting forth:—

(*a*) The name, address and ocupation of the applicant.

(*b*) The financial standing of the applicant so far as it relates to his ability to carry out the proposed works.

(*c*) The character of the proposed works.

(*d*) The name, or if unnamed, a sufficient description of the river, lake or other source from which water is proposed to be taken or diverted.

(*e*) The point of diversion.

(*f*) The height of the fall or rapid of such river, lake or other source of water at high, medium and low stages, with corresponding discharges of water per second, reckoned approximately in cubic feet.

(*g*) A reasonably accurate description, and the area, of the lands required in connection with the proposed works, such lands, if in surveyed territory, to be described by section, township and range, or river or other lot, as the case may be, and a statement whether such lands are or are not Dominion lands.

(*h*) If such lands be not Dominion lands, then the applicant shall give the name of the registered owner in fee, and of any registered mortgagee or lessee thereof, and of any claimant in actual possession other than a registered owner, mortgagee or lessee.

(*i*) The minimum and maximum amount of water-power which the applicant proposes to develop, and the maximum amount of water which he desires for such purpose.

(*j*) Sketch plan showing approximate locations of the proposed works.

(*k*) Elevations of head water and tail water of the nearest existing works, if any, below and above the proposed works.

(*l*) Particulars as to any water to be taken, diverted or stored to the detriment of the operation of existing works, if any.

(*m*) Particulars as to any irrigation ditches or reservoirs, or other works for irrigation within the meaning of the Irrigation Act, in use or in course of construction within the vicinity of the proposed works, and which might affect or be affected by the operation of the proposed works.

APPLICATION BY A COMPANY.

3. If the applicant be an incorporated company, the statement shall, in addition to the foregoing information, set forth:—

(*a*) The name of the company.

(*b*) The names of the directors and officers of the company, and their places of residence.

(c) The head office of the company in Canada.

(d) The amount subscribed and paid-up capital, and the proposed method of raising further funds, if required, for the construction and operation of the proposed works.

(e) Copy of such parts of the charter or memorandum of association as authorize the application and proposed works.

APPLICATION BY A MUNICIPALITY.

4. If the applicant be a municipality, then, excluding the special information to be given by a company, the following information shall be given:—

(a) The location, area and boundaries of the municipality.

(b) The approximate number of its inhabitants.

(c) The present estimated value of the property owned by such municipality, and the value of the property subject to taxation by such municipality.

MINISTER MAY REQUEST FURTHER INFORMATION.

5. The Minister of the Interior shall have the power to call for such other plans and descriptions, together with such measurements, specifications, levels, profiles, elevations and other information as he may deem necessary, and the same shall be furnished by and at the expense of the applicant.

THE AGREEMENT FOR A LICENSE.

6. Upon receipt and consideration of the application, and information accompanying same, the Minister of the Interior may, if he approve of the proposed works, enter into an agreement with the applicant, which agreement, in addition to usual conditions and covenants, shall contain clauses to provide as follows:—

(a) For a time within which the proposed works shall be begun.

(b) For a stated minimum amount of expenditure to be made in connection with the works annually during the term of the agreement.

(a) For a stated amount of water-power to be developed from the water applied for within a fixed period not exceeding five years.

(d) For summary cancellation of the agreement by the Minister if any of the above conditions have not been complied with.

(e) For defining and allotting the areas of Dominion lands within which the applicant may construct and operate the proposed works; and if there be no Dominion lands available for such purpose then for defining and allotting the lands in regard to which the applicant may exercise the powers given under section 35, subsection 3 of the Dominion Lands Act.

(f) For granting a license to the applicant, upon fulfilment of the said agreement, to take, divert and use for power purposes a stated maximum amount of water, in accordance with the application, and plans and specifications as approved by the Minister; the terms of such license to be twenty-one years at a fixed fee, payable annually, and such license to be renewable as provided for in these regulations.

(g) For granting a lease to the applicant of such Dominion lands as may be allotted under paragraph (e) of this section, and approved of by the Minister, such lease to be at a fixed rental for a term of twenty-one years running concurrently with the said license, and renewable in like manner, and as near as may be subject to all the terms and conditions thereof. When there are no Dominion lands available for such purpose, or when other lands are considered by the Minister to be more suitable

for such purpose, then the Minister shall define such lands in regard to which the applicant may exercise the powers given under section 35, subsection 3, of the Dominion Lands Act.

7. During the construction of any works for the development of water-power, the Minister of the Interior, or any engineer appointed by him for that purpose, shall have free access to all parts of such works for the purpose of inspecting same, and ascertaining if the construction thereof is in accordance with the plans and specifications approved of by the Minister, and whether the terms of the agreement, as provided for in the preceding section, are beng fulfilled.

THE LICENSE.

8. Upon fulfilment by the applicant of all conditions of the said agreement, the Minister of the Interior shall grant to the applicant a license as agreed upon; and such license shall contain clauses to provide as follows:—

(*a*) The term of the license shall be twenty-one years, renewable for three further consecutive terms of twenty-one years each, at a fixed fee payable annually, and to be readjusted at the beginning of each term, as hereunder provided.

(*b*) At the expiry of each term of twenty-one years the Governor in Council, may, on the recommendation of the Minister, order and direct that the license and any lease granted in connection therewith be cancelled: Provided that the Minister shall have given at least one year's notice to the licensee of intention so to cancel.

(*c*) If the licensee shall refuse to pay the license fee as readjusted by the Governor in Council, or as fixed by arbitrators chosen as provided in paragraph (*e*) hereunder, then in such case the Minister may renew the license at the former fee, or the Governor in Council may, on the recommendation of the Minister, order and direct that the license and any lease issued in connection therewith be cancelled.

(*d*) In either of the above cases compensation shall be paid to the licensee as provided for in paragraph (*e*) hereunder.

(*e*) On termination of the third renewal of such license, except in case of default on the part of the licensee in observance of any of the conditions thereof, or of any license granted in connection therewith, compensation shall be paid for the works to the amount fixed by arbitration, one arbitrator to be appointed by the Governor in Council, the second by the licensee, and the third by the two so appointed. If the licensee fails to appoint an arbitrator within ten days after being notified by the Minister to make such appointment, or if the two arbitrators appointed by the Governor General in Council and the licensee fail to agree upon a third arbitrator within ten days after their appointment or within such further period as may be fixed by the Minister in either such cases such arbitrator or third arbitrator, as the case may be, shall be appointed by the Judge of the Exchequer Court of Canada. In fixing the amount of compensation only the value of the actual and tangible works and of any lands held in fee in connection therewith shall be considered, and not the value of the rights and privileges granted, or the revenues, profits or dividends, being, or likely to be, derived therefrom.

(*f*) The license shall state the maximum amount of water which the licensee may divert, store and use for power purposes, and shall provide for the return to the stream, or other source of water, of the full amount so diverted.

(*g*) The licensee shall develop such power as, in the opinion of the Minister, there shall be a public demand for, up to the full extent possible from the amount of water granted by the license.

(*h*) Upon a report being made by the Minister of the Interior to the Governor in Council that the licensee has not developed the amount of power for which there is a public demand, and which could be developed from the amount of water granted by the license, the Governor in Council may order to be developed and rendered avail-

able for public use the additional amount of power for which there is, in the opinion of the Minister, a public demand, up to the full extent possible from the amount of water granted by the license, and within a period to be fixed by the Minister, which period shall not be less than two years after the licensee or person in charge of the existing works shall have been notified of such order, and in default of compliance with such order the Governor in Council may direct that the license, together with any lease issued under these regulations shall be cancelled, and the works shall thereupon vest and become the property of the Crown without any compensation to the licensee.

(*i*) Upon a report being made by the Minister of the Interior to the Governor in Council that a greater amount of water-power could be developed advantageously to the public interests from the same stream or other source of water from which the existing works derive power, and (1st) that the existing works could be enlarged or added to for such purpose, then the Governor in Council may authorize the Minister to offer the licensee the privilege of constructing and operating such enlarged or additional works at or in the vicinity of the existing works, and to grant such supplementary license as he may consider proper for such purpose, and if the licensee fail within six months thereafter to accept such offer, and in good faith to begin and carry on to completion such enlarged or additional works, and to complete same in acordance with plans and specifications approved of by the Minister, and within a fixed period not to exceed five years, and upon like conditions as the existing works were begun and completed; or (2nd) if the Minister shall report to the Governor in Council that the existing works, owing to their location or construction, cannot advantageously be enlarged or added to in order to develop further power sufficient to meet the probable demand, or would be a hindrance to other works contemplated for such purpose; or (3rd) that the existing works cannot, or will not, be any longer advantageously operated owing to the exercise of rights existing or created under the Irrigation Act; then in every such case, the Governor in Council may order and direct that the license, and any lease in connection therewith, and all rights thereunder, shall be cancelled, and the existing works shall thereupon vest in and become the property of the Crown: Provided always that in every such case compensation shall be paid to the licensee as provided for in paragraph (*e*) of section 8 of these regulations, together with a bonus apportioned as follows:—

(1) If the works have been in operation less than five years, a thirty per cent bonus upon the value of the works.

(2) If in operation more than five, and less than ten years, a twenty-five per cent bonus.

(3) If in operation more than ten, and less than fifteen years, a twenty per cent bonus.

(4) If in operation more than fifteen, and less than twenty years, a fifteen per cent bonus.

(5) If in operation twenty years or more, a ten per cent bonus.

(*j*) That the license shall not be transferable without the written consent of the Minister, and that if the licensee fail to keep and observe all or any of the conditions of the license, or any renewal thereof, or of any lease to be issued in connection therewith, then the license, together with such lease, shall in every such case be subject to cancellation by the Exchequer Court on the application of the Crown.

(*k*) That a schedule of rates and prices to be charged to the public for the use of power shall first be submitted by the licensee to the Board of Railway Commissioners of Canada for adjustment and approval before being put into effect, and that no rates or prices for power shall be legal or enforceable until such schedule has been so adjusted and approved nor if they shall exceed the amount fixed by such schedule; and that such schedule shall be readjusted and approved by the Board every seven years during the term of the lease and license, and all renewals thereof.

(*l*) That for the purpose of ascertaining the quantity of power actually developed, or capable of being developed, from the amount of water granted by such license, the Minister, or any engineer appointed by him for that purpose, shall have free access to all parts of the works, and to all books, plans or records in connection therewith, bearing on the quantity of power developed, and may make measurements, take observations and do such other things as he may consider necessary or expedient for such purpose, and the findings of the Minister, or such engineer, thereon shall be conclusive and binding upon the licensee.

(*m*) For the proper provision, as required by law, for the passage of logs and timber down the stream or other waterway affected by the works.

(*n*) For the erection and maintenance by the licensee of a durable and efficient fishway in the stream or other waterway affected by the works when so required by the proper officer or authority in that behalf.

(*o*) That the licensee shall have no right to any water beyond the amount stated in the license.

(*p*) For the indemnifying of the Crown against all actions, claims or demands against it by reason of anything done by the licensee in the exercise, or purported exercise, of the rights and privileges granted under the lease or license.

9. The agreements and licenses to be issued hereunder shall, subject always to the provisions of these regulations, be in such form and contain such provisions as the Minister may from time to time determine.

STORAGE OF WATER.

10. If at any time it is proposed by the applicant or the licensee to divert water from any lake or body of water for storage purposes, or to dam same in order to augment the flow of water in any stream from which water-power is to be developed, the applicant or licensee shall, in addition to other information required under these regulations, file plans as follows:—

(*a*) A general plan in duplicate, on tracing linen, showing the location of such lake or other body of water, and the lands to be submerged or otherwise affected, and contour lines showing the water level at high and low stages, and the level to which it is proposed to raise such water for storage, and the estimated storage capacity of such lake or other body of water.

(*b*) A plan in duplicate, from actual survey, by a Dominion land surveyor, and certified to by him, showing the lands to be submerged or otherwise affected by the proposed storage; the name of the registered owner in fee of such lands, and of any registered mortgagee or lessee thereof, and of any claimant in actual possession other than a registered owner, mortgagee or lessee.

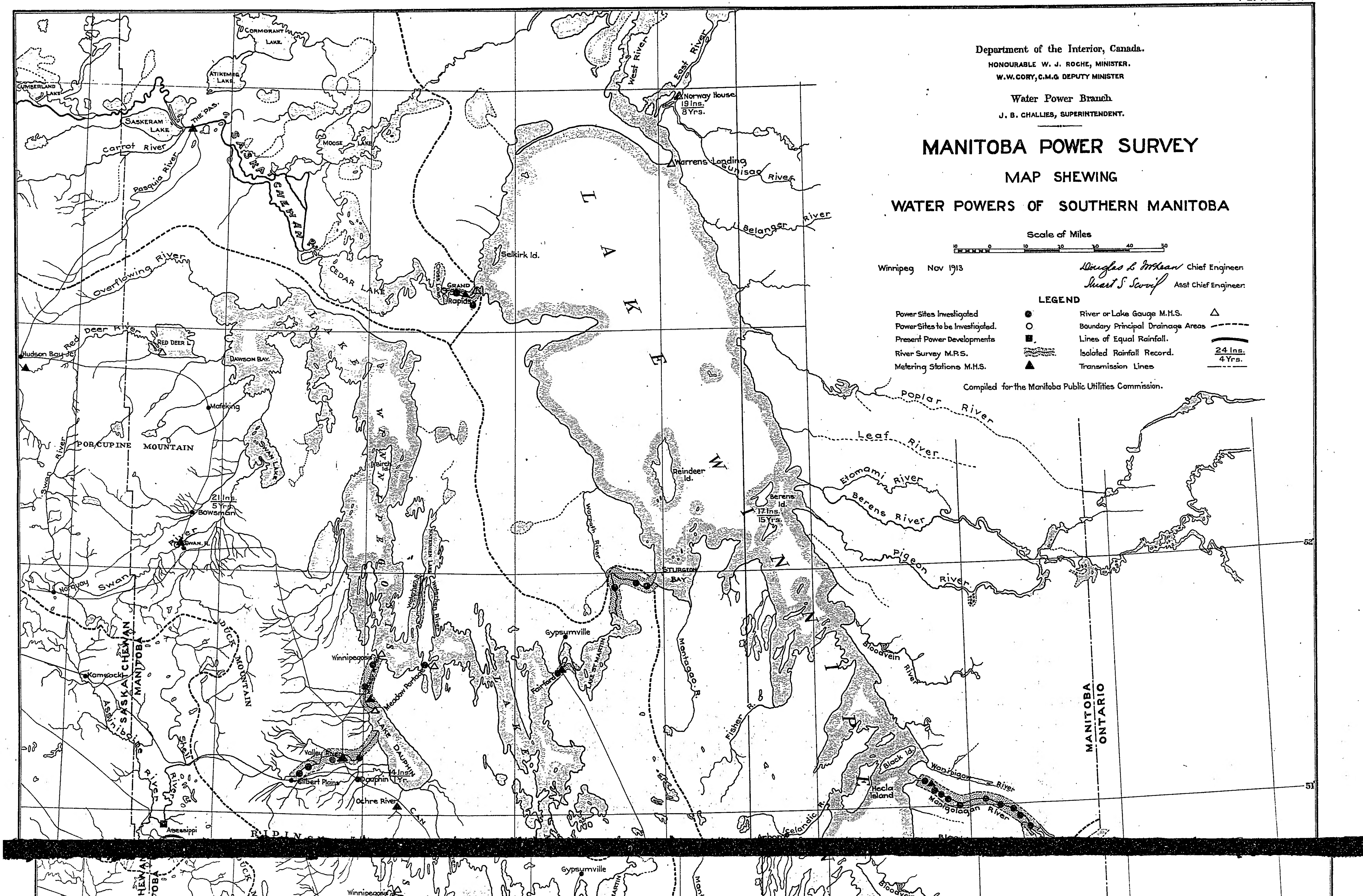
(*c*) A detail plan in duplicate on tracing linen, showing all dams and other works proposed to be constructed in connection with such storage.

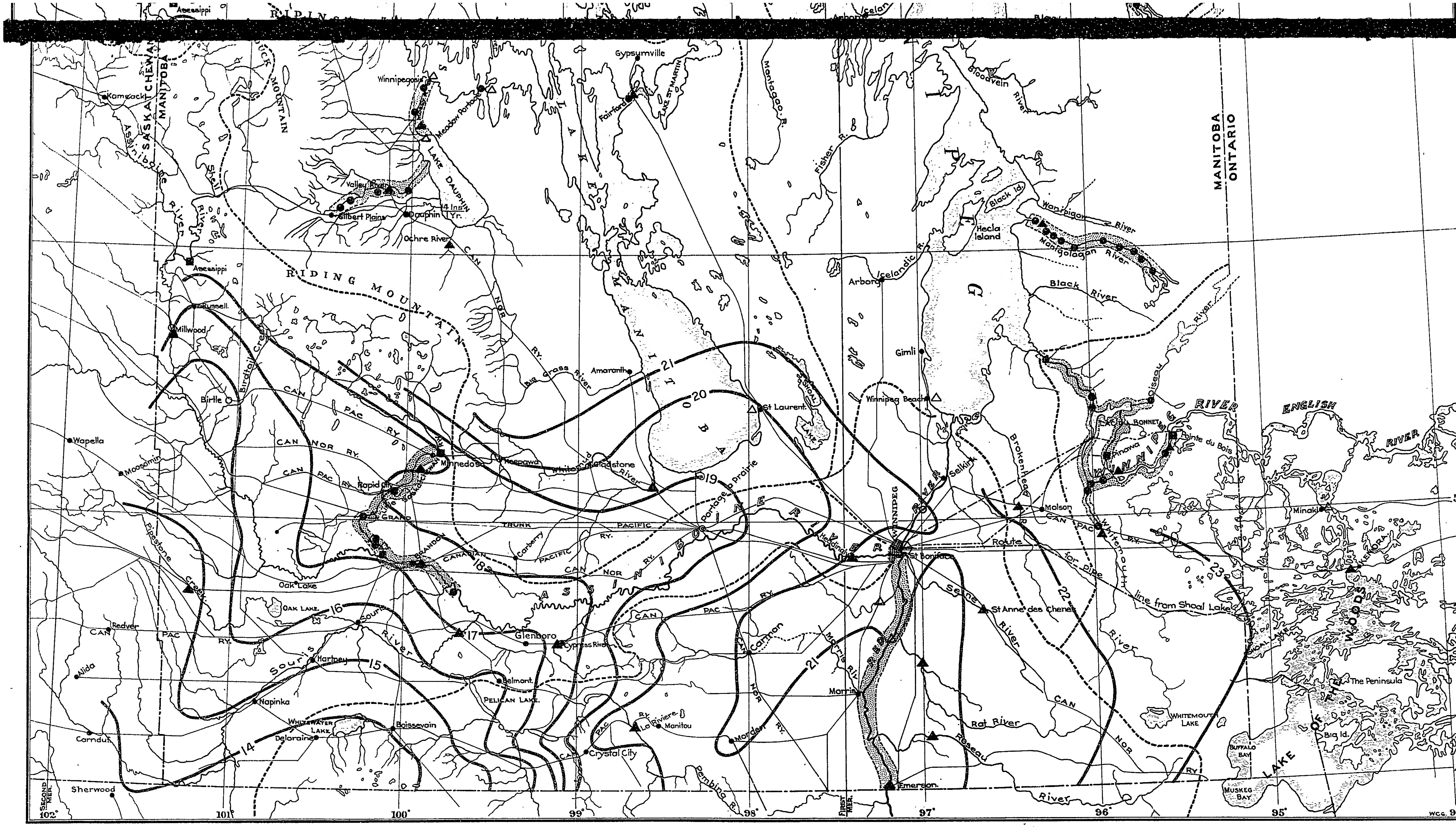
11. When the plans for such storage of water have been approved of by the Minister of the Interior, provision for same shall be made in the agreement for a license, or in the license itself, or in a supplementary license to be issued for such purpose, upon such terms and conditions as may appear to the Minister reasonable or expedient in the circumstances of each case, and subject to these regulations.

SMALL WATER-POWERS OF LESS CAPACITY THAN 200 HORSE-POWER.

12. If upon receipt and consideration of the information set out in sections 2, 3, 4 and 5, the water-power to be developed is found to have no greater capacity than 200 horse-power at the average low stage of water, the Minister may issue a lease and a license as may be required, authorizing the development of the proposed power; the lease and license to be for a period of ten years, subject to such special terms and conditions as may be considered advisable in each particular case, and renewable if, in the opinion of the Minister, the power has been continuously and beneficially used.

PLATE 34.


Department of the Interior, Canada.
HONOURABLE W. J. ROCHE, MINISTER.
W.W. CORY, C.M.G. DEPUTY MINISTER
Water Power Branch.
J. B. CHALLIES, SUPERINTENDENT.
MANITOBA POWER SURVEY
MAP SHEWING
WATER POWERS OF SOUTHERN MANITOBA
Scale of Miles
10 0 10 20 30 40 50
Winnipeg Nov 1913
Douglas L. McLean Chief Engineer.
Stuart S. Scovil Asst Chief Engineer.
LEGEND
Power Sites Investigated
Power Sites to be Investigated.
Present Power Developments
River Survey M.P.S.
Metering Stations M.H.S.
River or Lake Gauge M.H.S.
Boundary Principal Drainage Areas
Lines of Equal Rainfall.
Isolated Rainfall Record.
24 Ins.
4 Yrs.
Transmission Lines
Compiled for the Manitoba Public Utilities Commission.
CORMORANT LAKE
ATIKEMEG LAKE
CUMBERLAND LAKE
SASKERAM LAKE
THE PAS.
MOOSE LAKE
Carrot River
Pasquia River
SASKATCHEWAN R.
Overflowing River
CEDAR LAKE
Cross Lake
GRAND Rapids
West River
East River
Norway House
19 Ins.
8 Yrs.
Warrens Landing
Gunisao River
Belanger River
Selkirk Id.
LAKE WINNIPEG
Red Deer River
RED DEER L.
Hudson Bay Jc.
DAWSON BAY
Mafeking
PORCUPINE MOUNTAIN
Swan River
21 Ins.
5 Yrs.
Bowsman
SWAN R.
Swan Lake
LAKE WINNIPEGOSIS
Birch Id.
Reindeer Id.
Poplar River
Leaf River
Etomami River
Berens River
Berens Id.
17 Ins.
15 Yrs.
Pigeon River
Waterhen River
Waterhen Lake
Warpath River
STURGEON BAY
Norquay
Swan
DUCK MOUNTAIN
Gypsumville
LAKE ST. MARTIN
Fairford
Winnipegosis
Meadow Portage
Kamsack
SASKATCHEWAN
MANITOBA
Assiniboine River
Shell River
Valley R.
LAKE DAUPHIN
14 Ins.
1 Yr.
Gilbert Plains
Dauphin
Ochre River
Asessippi
Mossy R.
Fisher R.
Bloodvein River
Black Id.
Hecla Island
Wanipigow River
Manigotagan River
Icelandic R.
MANITOBA
ONTARIO
52
51



SASKATCHEWAN
MANITOBA
MANITOBA
ONTARIO
RIDING MOUNTAIN
DUCK MOUNTAIN
LAKE MANITOBA
LAKE WINNIPEG
LAKE DAUPHIN
LAKE ST MARTIN
LAKE WINNIPEGOSIS
LAKE OF THE WOODS
ASSINIBOINE R.
ENGLISH RIVER
WINNIPEG RIVER
RED RIVER
Kamsack
Assiniboine River
Shell River
Asessippi
Russell
Millwood
Birtle
Birdtail Creek
Wapella
Moosomin
Pipestone Creek
Oak Lake
OAK LAKE
Redver
Alida
Carnduff
Sherwood
Souris
Souris River
Hartney
Napinka
Deloraine
WHITEWATER LAKE
Boissevain
Valley River
Gilbert Plains
Dauphin
4 Ins. Yr.
Ochre River
Winnipegosis
Meadow Portage
Gypsumville
Fairford
Amaranth
Big Grass River
Minnedosa
Neepawa
Rapid City
Brandon
Carberry
Gladstone
Whitemud River
Portage la Prairie
Glenboro
Cypress River
Belmont
PELICAN LAKE
Crystal City
La Riviere
Manitou
Pembina R.
Morden
Carman
Morris
Morris Riv.
Emerson
St Laurent
Shoal Lake
Winnipeg Beach
Gimli
Arborg
Icelandic R.
Fisher R.
Mantagao R.
Hecla Island
Black Id.
Bloodvein River
Wanipigow River
Manigotagan River
Black River
Oiseau River
LAC DU BONNET
Pinawa
Pointe du Bois
Selkirk
WINNIPEG
St Boniface
Headingly
Brokenhead R.
Molson
Whitemouth River
Route for Pipe line from Shoal Lake
St Anne des Chenes
Seine River
Rat River
Roseau River
WHITEMOUTH LAKE
Minaki
KENORA
SHOAL LAKE
The Peninsula
Big Id.
BUFFALO BAY
MUSKEG BAY
CAN. PAC. RY.
CAN. NOR. RY.
GRAND TRUNK PACIFIC RY.
CANADIAN PACIFIC RY.
14
15
16
17
18
19
20
21
22
23
SECOND MER.
FIRST MER.
102°
101°
100°
99°
98°
97°
96°
95°
94°
49°
50°
51°
W.C.G.

CLASSIFIED LISTS OF REPORTS

OF THE

DOMINION WATER POWER BRANCH

The Reports published by the Dominion Water Power Branch with the exception of the Annual Reports, have been called Water Resources Papers, and have been numbered 1, 2, &c.

ANNUAL REPORTS.

Annual Reports previous to 1913 are included with the Annual Report of the Department of the Interior, and can be secured from the Secretary of the Department.

Annual Report for 1912-13, published 1914.

Annual Report for 1913-14, in press.

WATER RESOURCES PAPERS.

WATER RESOURCES PAPER No. 1.
Report of the Railway Belt Hydrographic Survey for 1911-12, by P. A. Carson, B.A., D.L.S., Chief Engineer. Published 1914.

WATER RESOURCES PAPER No. 2.
Report of Bow river power and storage investigations (Bow river west of Calgary,) by M. C. Hendry, A.M. Can. Soc. C.E., Chief Engineer in charge of surveys. Published 1914.

WATER RESOURCES PAPER No. 3.
Report on Power and Storage Investigations, Winnipeg river, by J. T. Johnston, A.M. Can. Soc. C.E., Hydraulic Engineer of Water Power Branch. In course of preparation.

WATER RESOURCES PAPER No. 4.
Report of the Manitoba Hydrographic Survey to the year ending 1914, by M. C. Hendry, A.M. Can. Soc. C.E., Chief Engineer. In course of preparation.

WATER RESOURCES PAPER No. 5.
Preliminary Report on the Pasquia Reclamation Project, by T. H. Dunn, C.E., O.L.S., Chief Engineer in charge of Reclamation Survey. Published 1914.

WATER RESOURCES PAPER No. 6.
Report on cost of various sources of power for pumping in connection with the South Saskatchewan Water Supply Diversion Project, by H. E. M. Kensit, M.I.E.E. Mem. Am. Inst. E.E. Mem. Can. Soc. C.E. Published 1914.

WATER RESOURCES PAPER No. 7.
Report on the Manitoba Water Powers, by D. L. McLean, S. S. Scovil and J. T. Johnston, compiled for the Manitoba Public Utilities Commission. Published 1914.

WATER RESOURCES PAPER No. 8.
Report of the British Columbia Hydrographic Survey for 1913, by R. G. Swan, A.M. Can. Soc. C.E., Chief Engineer. In press.

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Report of Red river Navigation Surveys, by S. S Scovil, B.Sc., Assistant Chief Engineer of Manitoba Hydrographic Survey. In course of preparation.

WATER RESOURCES PAPER No. 10.
General Guide for Compilation of Water Power Reports of Dominion Water Power Branch, prepared by J. T. Johnston, A.M. Can. Soc. C.E., Hydraulic Engineer of Water Power Branch. In press. Limited edition.

WATER RESOURCES PAPER No. 11.
Final Report on the Pasquia Reclamation Project, by T. H Dunn, C.E., O.L.S. Chief Engineer in charge of Reclamation Survey. In press.

WATER RESOURCES PAPER No 12.
Report on Small Water Powers in Western Canada, and discussion of sources of power for the Farm by A. M. Beale, A.M. Can. Soc. C.E. In press.

WATER RESOURCES PAPER No. 13.
Report on the Coquitlam-Buntzen Hydro-Electric Development, by G. R. C. Conway, M. Inst. C.E., M. Can. Soc. C.E., Chief Engineer of the British Columbia Electric Railway Company, Limited. In press.